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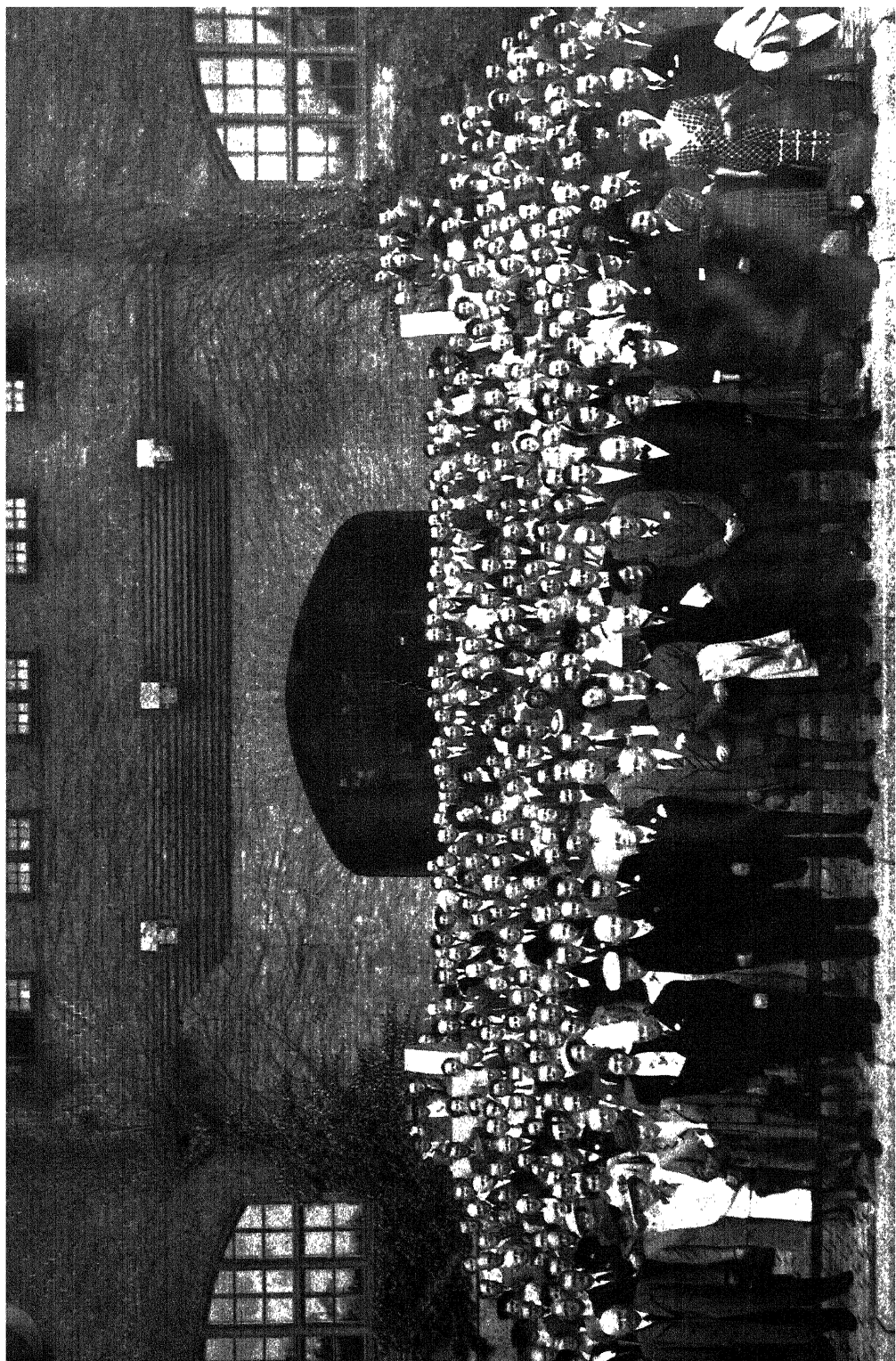
INDIAN AGRICULTURAL  
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EIGHTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

VIII<sup>E</sup> CONGRÈS INTERNATIONAL d' ENTOMOLOGIE

VIII. INTERNATIONALER KONGRESS FÜR ENTOMOLOGIE

P R O C E E D I N G S

PROCÈS-VERBAUX

VERHANDLUNGEN

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STOCKHOLM  
AXEL R. ELFSTRÖMS BOKTRYCKERI AB  
1950

## PREFATORY NOTE

The aim of an international congress, to serve the cultural progress of the peoples through the interchange of experiences and the comparison of methods tested under the most varied environmental conditions, has been fully attained by the VIIIth International Congress of Entomology, as unanimously agreed upon by the members.

The transactions of the congress are now lying completed before us. The contents of the volume to be published bear witness of the work performed by the congress which was attended by reporters from 22 nations. We express our hearty gratitude to all these reporters. A great number of the cleverest men from all nations have made the results of their knowledge and skill available for the benefit of this international cooperative work. All those who have had a part in this work will take pride in cooperating to such a great extent towards the advancement of entomology everywhere in the world.

On a superficial perusal of this volume already, we capture again some of the atmosphere of enthusiastic activity displayed at the meetings during the congress and the festive joy of the social entertainment is revived. Many bonds of friendship were formed during those days without discrimination of nationality. The importance of the congress lies also herein, it established professional and personal relations from nation to nation thus conducing towards a better mutual understanding between the peoples.

The present publication is intended to offer all friends of entomology the possibility of studying the transactions of the congress at leisure and of deriving benefit from them for their practical and scientific activity. May this work contribute to the promotion of entomology all over the world. Bearing this purport in mind I herewith offer as secretary general to the VIIIth International Congress of Entomology the transactions of the congress for publication.

Stockholm, Summer 1950.

*Professor Dr. V. Butovitsch.*

## DEDICACE

La tâche d'un congrès international, à servir le progrès culturel des nations par échange d'expériences et par comparaison des méthodes éprouvées dans les conditions d'entourage les plus différentes, a été entièrement remplie par le 8<sup>ième</sup> Congrès International d'Entomologie, quant au jugement conforme des participants.

Maintenant, les rapports des discussions du congrès sont achevés. Le contenu du tome publié porte témoignage des travaux du congrès auxquels ont participé des rapporteurs de 22 nations. Tous ces rapporteurs nous remercions cordialement. Plusieurs des hommes les plus savants ont donné les résultats de leurs connaissances et de leur devoir à la disposition en faveur de ce travail de communauté internationale. Tous ceux qui ont participé à cet ouvrage seront fiers d'avoir eu une part particulière de l'avancement de l'entomologie de tout le monde.

Déjà en revisant superficiellement ce tome nous sentons de nouveau l'atmosphère des jours du congrès, l'esprit de bon travail des séances et la joie des arrangements de fête. Beaucoup d'amitiés ont été faites ces jours, indépendamment d'aucune nationalité. C'est aussi d'importance que ce congrès a produit des liaisons professionnels et personnels entre les pays et ainsi a servi à causer une meilleure entente des nations.

La publication actuelle doit mettre tous les amis de l'entomologie en état d'étudier en paix les rapports du congrès et en profiter pour leur travaux pratiques et scientifiques. C'est à désirer que cet ouvrage contribue à avancer l'entomologie de tout le monde. Ainsi je rends donc publics, comme secrétaire général du 8<sup>ième</sup> Congrès International d'Entomologie, les rapports du congrès.

Stockholm, été 1950.

*Professor Dr. V. Butovitsch.*

## ZUM GELEIT!

Die Aufgabe eines internationalen Kongresses, durch Austausch von Erfahrungen und Vergleich der unter den verschiedensten Umweltbedingungen erprobten Methoden dem kulturellen Fortschritt der Völker zu dienen, hat der VIII. Internationale Kongress für Entomologie nach übereinstimmendem Urteil der Teilnehmer voll erfüllt.

Nun liegen die Kongress-Verhandlungen fertig vor uns. Der Inhalt des hiermit der Öffentlichkeit übergebenen Bandes legt Zeugnis ab von den Arbeiten des Kongresses, an denen Berichterstatter aus 22 Nationen beteiligt sind. Allen diesen Berichtstattern sei herzlich gedankt! Eine Reihe der tüchtigsten Männer aus allen Ländern hat die Ergebnisse ihres Wissens und Könnens zum Besten dieser internationalen Gemeinschaftsarbeit zur Verfügung gestellt. Es wird alle, die an diesem Werk beteiligt sind, mit Stolz erfüllen, einen so besonderen Anteil an der Förderung der Entomologie in aller Welt zu haben.

Schon bei flüchtiger Durchsicht dieses Bandes weht uns wieder die Atmosphäre der Kongresstage entgegen, die arbeitsfrohe Stimmung der Kongress-Sitzungen und die Festesfreude der gesellschaftlichen Veranstaltungen. Viele Freundschaften wurden in diesen Tagen geschlossen ohne Unterscheidung der Volkszugehörigkeit. Auch darin liegt die Bedeutung des Kongresses, dass er fachliche und persönliche Verbindungen von Land zu Land knüpfte und damit einem besseren Verständnis der Völker untereinander diene.

Alle Freunde der Entomologie sollen durch die vorliegende Veröffentlichung in die Lage versetzt werden, die Kongressberichte in Ruhe zu studieren und daraus Nutzen für ihre praktische und wissenschaftliche Tätigkeit zu ziehen. Möge das Werk dazu beitragen, die Entomologie in aller Welt zu fördern. In diesem Sinne übergebe ich als Generalsekretär des VIII. Internationalen Kongresses für Entomologie die Kongress-Verhandlungen hiermit der Öffentlichkeit.

Stockholm, im Sommer 1950.

*Professor Dr. V. Butovitsch.*

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## THE PROGRAMME

*Saturday August 7th*

L U N D

Excursion in Scania.

*Sunday August 8th*

L U N D

Welcome speech by the Prof. Hanström of the University of Lund.

Lecture by Mr. Kjell Ander about Entomology at the University of Lund. (see page 44)

Visit of the Zoological Institution and its Museum.

Lunch at the Students Union.

Visit of the Museum of Cultural History.

Visit of the cathedral.

Dinner at Grand Hotell.

*Monday August 9th*

Lunch at "Anglais" for the members of the executive committee, given by the organizing committee.

First session of the executive committee.

Official opening of the congress in the Concerthall.

Address by the Prime Minister of Sweden T. Erlander. (see page 31)

Address by Prof. Trägårdh, president of the congress. (see page 32)

Address by Dr. Jordan, permanent secretary of the International Congress of Entomology. (see page 38)

Address by Prof. Jeannel, representing the foreign delegates. (see page 40)

Social evening at Hasselbacken to enable the members to meet each other.

*Tuesday August 10th*

General session in Östermalms Läroverk.

Official photograph of the congress.

Lunch at Piperska Muren, given by the Captain Richard Kjellberg-BAS-Ltd.

Meetings of sections.

*The Ladies programme*

Visit of Skansen.

*Wednesday August 11th*

U P P S A L A

By busses to Hammarby.

Initiating speech by Prof. O. Lundblad. (see page 49)

Visit of Linnés Hammarby.

Departure by buss to Uppsala.

Lunch at Östgöta Nation and "Flustret."

Visits: Zoological Institution with the collections of Linné and Thunberg.

Carolina Rediviva: a special exhibition of zoological and especially entomological papers.

Tea at the University with the presence of the Rector.

Visit of the cathedral.

*Thursday August 12th*

Meeting of sections.

*An evening in Drottningholm*

Visit of the theatre and the museum.

Short concert.

Supper in the foyer.

*The Ladies programme*

Visit of Nordiska Kompaniet.  
Lunch on the top terrasse.

*Friday August 13th*

Visit of the entomological section of the Swedish Museum of Natural History, the Forest Research Institute and the Institute of plant protection.  
Lunch at the Museum of Natural History.  
Meeting of sections.  
In the evening: Invitations by Swedish families.

*The Ladies programme*

"Under the bridges" in a motor-boat.  
Lunch at the Swedish Museum of Natural History, entomological department.

*Saturday August 14th*

Meeting of sections.  
Lunch at Blå Porten.  
General session.  
Final speech by the president of the congress. (see page 50)  
Reception in the Town Hall in honour of the members of the congress offered by the town of Stockholm.

*Sunday August 15th**Common excursion in the Stockholm archipelago*

Departure on S/S "AGA III".  
The trip is running via Skurusundet to Saltsjöbaden.  
Lunch on board.  
Stay in Saltsjöbaden, walk to the Observatory.  
Dinner in Vaxholms Hotell.

*Monday August 16th*

Visit of the sugar beet improvement station and its research field belonging to the Swedish sugar Limited.

*Excursion to Lapland**Tuesday August 17th*

Arrival at Abisko.  
Excursion in Björkliden and Nationalparken.

*Wednesday August 18th*

Excursion to Vassijaure, Pålnoviken and Maivantjokko.

*Thursday August 19th*

Excursion to Narvik and Sjømbotten.

*Friday August 20th*

Excursion to Jebrenjokk and Pesisvare.  
Departure from Abisko.

*Excursion for forest entomologists in Central Sweden**Monday August 16th*

Arrival at Hofors.  
Excursion in the district of Hofors Bruk and visit of Svenska Kullagerfabriken AB's establishments (steel mills a.s.o.)  
Meals in Hofors. Host: SKF, Hofors.  
To Falun for night quartering.

*Tuesday August 17th*

Departure to Rättvik.

Excursion in the district of Kopparfors AB at silurmark.

Meals in Rättvik. Host: Kopparfors AB.

Night quartering in Rättvik.

*Wednesday August 18th*

Departure from Rättvik.

Arrival at Älvdalen.

Excursion in Älvdalens Besparingsskog.

Meals in Älvdalen. Host: Älvdalens Besparingsskog.

Night quartering in Älvdalen.

*Thursday August 19th*

Excursion in the district of Stora Kopparbergs AB in Idre.

Visit of Grövelsjön.

Meals in Grövelsjön. Host: Stora Kopparbergs Bergslags AB.

## STATSMINISTER ERLANDER

An international scientific congress has besides the professional exchange between colleagues an essential importance in so far as it is a manifestation of scholarly and scientific internationalism. Scientific research knows of no national or ideological bounds. It is universal. This apparently axiomatic statement need not be made if not our very generation had experienced frightening attempts to vindicate an opposite opinion, if we were not made aware that we have to be on our guard against tendencies to enslave scholarly research to nationalistic or imperialistic interests. The isolation caused by war and the economical difficulties of international communication cannot prevent in process of time the universality of science to express itself. It is therefore a great joy for a free country to welcome an important international scientific congress.

Research must essentially be free. It is no empty phrase which in the expression "free research" has become a technical term of our civilization. It must be free from prejudices and preconceived opinions. It must also be free from encroachments alien to its nature. There is in fact an interplay between science and liberty. The community's own freedom, the external as well as the internal, must ever be subject to unprejudiced investigation in order to attain development and perfection. And society must guarantee science its freedom. Science has a rightful claim to this. For it is not a luxury, a handsome superstructure of great but not of primary value. No, it is an integrant part of our social culture which is no less than indispensable. This implies also that science naturally takes service with the community, willingly and on no other compulsion than its own inner aim to serve human life and the indivisible culture.

Scientific research in its relation to social utility is a subject of current interest at this congress. Entomology is a very special branch of science concerned with the investigation of moments in nature's organic life concealed from us laymen. But entomology also performs a practical task for the benefit of the world's economy. This has great importance for this country, her agriculture and forestry, her milling trade and other food production. I am glad of this opportunity to say to the present entomologists from the entire world a word of thanks from the community for the invaluable service you are rendering social economy.

With these words I have the pleasure of welcoming the eighth international congress for entomology to our country. The Swedish Government wishes you good results of your deliberations. We are well aware of their importance. And we greet you as representatives of that spirit of free international exchange without which the civilized world cannot endure.

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## PRESIDENTIAL ADDRESS AT THE VIII<sup>TH</sup> INTERNATIONAL CONGRESS OF ENTOMOLOGY IN STOCKHOLM 9<sup>TH</sup> AUGUST 1948

*By Ivar Trägårdh*

It is generally accepted as a fact that the insects made their appearance on dry land in the middle of the Devonian epoch, some 450 million of years ago. If we include the arachnids the first scorpion appeared already during the Silurian epoch which adds another 60 million years to the age of the land arthropods. In comparison with this enormous space of time man appears, as it were to have been born yesterday, being only about one million years old.

Considering the long time the insects have had to their disposition to perfect their evolution it is not surprising that some of them have managed to solve one of the most important problems which have confronted man ever since he began to organize his hordes into some kind of society, that of constructing a community where there are no poor or destitutes, the food being scrupulously divided between all the members. This problem was, as a matter of fact, solved independently by many social insects, notably the termites and the ants, millions of years before man appeared on the scene.

When I draw your attention to this fact it is of course not my intention to make propaganda for the system adopted by the insects. I only wish to emphasize that the goal which the rulers, statesmen and politicians still strive to reach in various and often quite opposite ways, this goal some insects reached millions of years ago.

But the organization of the social insects is only one of the marvels of insect life. In many respects the insects could have been our teachers if we had only been sage enough to copy their methods. When our ancestors were seeking shelter in caves which sometimes they had to wrest from the wild beasts, the termites had long ago solved the housing problem, building large mounds, containing numerous subterraneous rooms and galleries, the whole mound being fabricated of mortar, prepared by the termites themselves. Long before papyrus was used for paper the hornets built their elaborate nests out of wood-pulp made of dry wood. One could easily write a whole book about the marvels of insect life and such books have also been written.

The priority of many inventions which mark our way from savage hunters and food gatherers to comparatively civilized man, such as building, storing food for the lean seasons, pottery making, not to mention such inventions as using slaves or milking domesticated cattle, plantlives in the case of the ants, belonging to the insects.

It is well known that many of the groups of quadrupeds which developed during the geological epochs and flourished to such extent that they seemed to be the masters of the earth, now are extinct or represented by some insignificant rests.

Not so the insects. They have not only been able to hold their own in spite of all the revolutionary changes which the earth has undergone, but they have flourished to such an extent that the number of insect species more than equals the number of species of all other animals taken together. This fact in itself seems to offer conclusive evidence that the type of organisation and structure possessed by the insects has been very successful. How successful the insect type has been is also forcibly brought to our minds when we learn that the insect, first found from the Devonian epoch, the collembola or springtails, differ very little from those of to-day. The same applies



to the cockroaches of to-day which differ very little from their ancestors from the Carbonic epoch.

One may well ask then in what respects the insect type was so successful. Dr. Imms of Cambridge has formulated the answer in four words: flight, adaptability, skeleton and size. To this one could perhaps add great fecundity.

1. It is surely superfluous to enlarge upon the great advantage of being able to fly nowadays. But perhaps quite a few of you are inclined to look down upon the insects because they have no passengers.

This is not true. Many insects have passengers, albeit not of the most respectable kind, but rather stow-aways who have not paid for their tickets. But, on the other hand, these passengers generally manage to arrive safely to their place of destination. A great number of mites use the insects as transport planes, not at random but the breeding ground of the pilot is also the breeding ground of the passenger.

In the month of May I spent some time in the institute of Professor Jeannel. Amongst his great collections are about 200 boxes containing the large beetles, belonging to the Passalidae. With the help of one of his assistants I managed to collect from the ventral side of the beetles a great number of very interesting mites, from New Guinea, Borneo, Java, Madagascar, the Ivory Coast, Trinidad and many other localities. Thus the remarkable adhesive power of the ambulacres of the mites was turned to scientific use.

But the ability of flight confers many other advantages upon the insects. Think of the mating time. How much easier, not to mention more delightful is it not, let us say, to a young may-fly male, who is going awooing to look for a may-fly damsel in a cloud of may-flies, rhythmically dancing up and down in the still evening above the mirror of a lake. Instead of crawling laboriously about in the undergrowth and perhaps having to run for his life to evade the attacks of hungry ground-bettles.

2. The power of adaptation of the insects is amazing. If you wander far out in the most sterile and glowing desert you will find insects. If you climb the highest mountains you will find at least spring-tail provided there is a small patch, covered by moss and lichens. You will find them in the hot springs of Iceland, in the salt-lakes of Utah and in the pools of petroleum round the oil-wells of Southern California. You will find them in the pit-props of the deepest coal-mines.

3. The skeleton of the insects is not inside their body but forms a protecting armour round their bodies preventing them from desiccation. But what a marvellous armour, hard and flexible at the same time. And when during the postembryonic growth the armour becomes too tight the old one is simply shedded, a new skin, more ample than the old one, taking its place.

4. The small size of the insects gives them many advantages. It enables them use food-stuffs which are so small that there is no competition from other animals.

I have now used some minutes in trying to give you an idea of how gloriously well equipped creatures the insects are. Perhaps now some inquisitive mind will ask. Granted that this picture is true. granted that at the time the insects appeared the only vertebrates were the fishes.

Why are not then the insects the masters of this earth instead of man. You may of course consider this an absurd question. It has, however, been asked by eminent and serious-minded entomologists and it has also been answered. It is true that the organization of the insects is marvellous in many respects. But there is, very fortunately for us, a serious deficiency in it. The insects have no lungs in which their blood can

easily renew its supply of oxygen. The air penetrates into the body through small openings in the cuticle and then through the air tubes which with their very fine capillaries penetrate into all tissues. In these fine tubes the air can only travel through diffusion and this decreases very rapidly with increasing distances from the spiracles. This imperfect method of breathing forms an unscalable barrier to any increase in size of the insects above the length of about four inches. The small size of the insects, brought about by their defective method of breathing prevented them from becoming the masters of the earth.

When, as it were yesterday, our ancestors appeared on the scene we may safely assume that they were infested by the same vermin as belonged to the apparel of the monkeys, viz, lice and fleas. But with these exceptions the conflict between the insects and man had not yet begun in earnest, which was rather fortunate for man, daily and nightly as he must have been occupied in holding his own against all the wild beasts. As a hunter he was of course tormented by the bites of ticks and chiggers, swarming in the undergrowth of the forests. And in some damp localities the mosquitoes sucked his blood and maybe caused him to shiver from malaria.

I think we may say that the insects became his earnest foes when he left the hunting and food-gathering stages and learned to cultivate plants for food. Because practically every plant is attacked by one or several herbivorous insects. Hence, when man started his career as farmer, covering the ground round his huts with a few cultivated plants, to the exclusion of other plants which from his point of view were weeds, the inevitable result of this in itself fundamental progress, on which our civilisation rests, was that the insects feeding on these plants were greatly favoured and started to propagate at a rate, hitherto unknown to them.

In the same way, whenever man added some new edible and nourishing plants to his menu, the number of injurious insects automatically increased. And the same will happen to-day whenever a new plant is cultivated. And when he started to collect and store provisions of seeds and other products of plants he incurred the attacks of the innumerable pests of stored food-stuffs.

This was simply bound to happen and we cannot blame our ancestors for it because it was in the nature of things. But we cannot acquit modern man from the charge that the wholesale distribution of our most injurious insects all over the world is the result of his failure to reckon with this danger, a danger which is now more serious than ever before because the modern methods of transport have nullified the former barriers, the oceans and the high mountains which previously prevented the unlimited spreading of the pests.

Ever since the primitive civilisation began, some believe in Egypt, about 5,000 years ago, man has suffered from the ravages of insects—as is related in the Bible about the locusts of Egypt—and man did not know how to protect himself from his foes, which often caused famine. And even much later, in the fifteenth century the only one could think of was to ban the evil-doers from the pulpit.

At last applied entomology, or as the Americans prefer to call it, probably on account of the propaganda value of the word, economic entomology, started about hundred years ago. It was at first a rather feeble child and it is perhaps significant that in England it was a lady, miss Ormerod, who tended the child with such care that it soon grew to be a sturdy infant.

But there were in the beginning many obstacles in the path both of theoretical and economic entomology. The older ones of us who have studied at universities in

the beginning of this century will doubtless recall how the zoologists looked down upon the entomologists. We were generally called bug-hunters or worse. To them scientific zoology consisted in cutting small pieces of in alcohol preserved animals in thin sections which were afterwards most beautifully stained in red or blue. That was science! One of my professors in zoology distinctly stated in print, that he did not consider entomology a science. As I happened at that time to be private dozent in entomology in Upsala, his opinion of me was certainly not very flattering.

Well, we managed to survive somehow and to become entomologists in spite of the professors. And even in Sweden entomology is nowadays regarded as a science by most educated people. But we are a little behind the times, it is true, and there are not yet any professors of entomology at any of our universities. But there soon will be at least one.

When the economic entomologists started they were in their turn slighted by the systematists who looked upon them as a kind of farmers, dabbling in entomology but with nothing like the same standing in science as the true entomologists.

But even other dangers lurked in the their path. They were, especially in Germany, lumped together with the mycologists under the common name of phytopathologists. This term is held to include the damage done to plants by insects and fungi and the result of this has sometimes been that botanists have been placed in charge of entomological work.

The Americans have never been able to see the reason why the attack of an insect should be called a disease of the plant; one might as well call a cow, eating grass, a disease of the grass. Nor have have they understood why two services, requiring different technique and training should be combined under a single, misleading term.

This is not the time nor the place to dwell any longer on the development of economic entomology. But a few, pertinent examples may be mentioned of what it has achieved, when it has been sufficiently supported by the government concerned.

The orange and lemon trees of California were saved from total destruction from the cottony cushion scale by the timely introduction from Australia of a few ladybirds *Novius cardinalis*, the descendants of which in an incredibly short time controlled the scale-insects.

When in the eighties the frenchmen started building the Panama canal under the famous de Lesseps, the constructor of the Suez canal, the chief cause of their failure to finish the project was a mosquito which spread the dangerous yellow fever, probably introduced to America at the same time as the so-called black ivory from the West Coast of Africa. It is heartrending to read about the misery of these years when a great part of the white labourers, engineers, surgeons, and nurses was virtually wiped out in a few months time.

When in 1902 the Americans bought the shares in the French company the first step they took was to exterminate the mosquitoes. Under colonel Gorgas they managed to do so in a few years so that Panama, hitherto a country where a man took his life in his hands, became one of the healthiest places known. Incidentally malaria was also wiped out.

The sugar plantations of Hawaji were saved from utter destruction by the sugar cane-borer, when the intrepid dr Muir after four years of wanderings, accompanied by incredible hardships and occasional breakdowns from fevers, finally succeeded in

discovering a tachinid fly on a little island between New Guinea and Australia. He managed to introduce the fly in Hawaji where it did everything that was expected of it.

But the friendly insects may also be employed in other ways, f.i. for the purpose of getting rid of dangerous weeds. *Opuntia inermis* was introduced into Australia as a food plant to the cochineal scale, which yields the precious red dye. The introduction was a failure from an economic point of view and the *Opuntia* became a pest which spread so rapidly that in 1925 in Queensland and New South Wales it occupied a practically unbroken area of 60 million acres, to the exclusion of all other plants.

After a long period of inactivity from the governments concerned they finally turned to the entomologists for help. An expedition was sent to Mexico and other countries where the cactus was endemic. Its purpose was to make a collection of all insects, feeding on the cactus. About 150 different species of cactus-feeding insects were collected and brought to Australia. But of these only one, a little moth, called *Cactoblastis cactorum* was found to be effective. From the beginning only 3,000 eggs were collected but the moth propagated so rapidly that between 1928 and 1930 3,000 million eggs could be distributed.

The moth larvae feed in colonies in the tissue of the plant which they devour. Pathogenic microorganisms rapidly follow in their wake and the cactus soon turns into a rotting mass of pulp.

It would be easy to relate quite a number of other quite as spectacular cures as these. But it is superfluous, because the fact here briefly mentioned offer us convincing evidence regarding two fundamental points.

1. The unlimited propagation of obnoxious insects spells ruin for the country invaded.

2. Economic entomologists is quite confident that, provided of course, that their work is liberally supported by the governments concerned, they can defeat the obnoxious insects.

It cannot be doubted that the great achievements of economic entomology gradually produced a change in attitude of the government officials. They began to realize that money spent on economic entomology paid a good dividend, even if sometimes the expenses seemed rather high. When the coconut plantations of Fiji were threatened with extermination by the little moth *Levuana iridescens* and Dr. Tothill and his assistants succeeded in finding in Java a suitable tachinid fly, it has been estimated that the cost of securing 315 flies worked out at 11 pounds per fly. But the coconut plantations and the copra industry of Fiji was saved.

Sometimes the changes in the attitude of the authorities has been so profound and rapid that one is inclined to describe it with a term, borrowed from entomology, metamorphosis. 12 years ago I applied to the government for a grant of 5,000 sw. cr. to make experiments with the modern methods of fighting the forest insects from airplanes. I did not get a cent. But this spring the parliament unanimously voted the for such a small country as Sweden enormous sum of 480,000 sw. cr. for the purpose of dusting vast tracts of forests from a helicopter against several of our most dangerous forest pests.

The few facts here presented are certainly most encouraging to the economic entomologists. Yet we must not repose on our laurels but hasten forward. And in order to do so I venture to suggest that a still more intimate cooperation between the entomologists of the world is necessary. We must organize our activities according to a wellfounded and common plan.

Now I am perfectly aware of the fact that the word "planning" is apt to leave a bad taste in your mouths. It recalls to us all the schemes and attempts of planning to which every citizen in every country has of late been subjected with the result that his right to choose his own way of living has been most grievously curtailed.

Still I must insist upon the necessity of planning our work at last in some respects. In order to make it plain to you what my intentions are I will mention only two instances.

Ever since the Japanese discovered that the larvae of some Trombiculidae, the so-called chiggers, transmit the tsutsugamushi or flood-fever an ever increasing number of acarologists all over the world are busily making card indexes of the whole literature, dealing with these mites. Lawrence in Pitermaritzburg. Womersley in Australia, Miss Hoffman in Mexico, Fuller in U.S.A. Radford in England and André in Paris and probably several others are each one occupied with the same work. Were it not possible that this enormous waste of a precious time could be avoided in some way? Either that the specialists divided the work between them or, better still, that the cooperation of a great scientific library was secured.

Further improvements in the study of the insects may be made if we agreed to take a thorough survey of all the groups of insects which today are studied in the different countries. The result of such a survey would no doubt be that while some large groups as the lepidoptera and coleoptera attract the interest of say 90 percent of the entomologists, other groups quite important both from a systematic and an economic point of view, such as the parasitic hymenoptera and diptera, are studied by too few scientists.

Every entomologist, for instance, who has been studying the ecology of injurious insects, can testify how often he has been faced by the difficulty or even impossibility to find specialists, qualified and willing to determine the parasites, emerging from the different developmental stages of the injurious insects. Might it not be possible to abolish this state of things which so greatly impedes the work of the ecologist and the economic entomologist. The first step would be to organize such a survey and publish the results so that we know where we stand. The next step would be to stimulate the interest of the entomologists to take up the study of those groups which are being neglected. At the universities young students could receive guidance from their professors and scholarships could be arranged for them, even travelling scholarships which would enable them to study a special group in the laboratory of some eminent specialist, in whatever country he resided. By theses and other devices it would perhaps be possible in due time to distribute the insects more evenly amongst the entomologists than they are now.

I hope that during this congress there will be opportunities to discuss the points raised here so that we will be able to contribute to the further development and increasing efficiency of entomology.

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## H. E. KARL JORDAN, Permanent Secretary of the Executive Committee

Mr. President, Your Excellency, Ladies and Gentlemen.

At the last General Meeting of the VIIth International Congress of Entomology (Berlin, 1938) the agenda contained the question where and in which year the VIIIth Congress should take place. As the several invitations received were all of a preliminary nature the matter was left for later decision in the hands of the Executive Committee, the activities of which ensure the continuity of our International Congresses. After some correspondence with colleagues of high standing in the countries concerned it was agreed that the VIIIth Congress should meet at Stockholm in 1941 and the IXth Congress take place in Holland in 1945 when the *Nederlandsche Entomologische Vereeniging* would celebrate its centenary. The outbreak of war postponed that programme and my correspondence as Secretary of the Executive Committee came almost to a standstill. It was a fortunate circumstance that I was also a member of the Executive of the International Commission on Zoological Nomenclature and as such could assist the Secretary of the Commission in clearing off arrears in the publication of cases of Nomenclature which had already been decided by the Commission, many of cases of Nomenclature which had already been decided by the Commission, many of them Entomological or affecting Entomology and all of international application. Long years of service on the Commission had kept me in close touch with the philosophy on which the great Carolus Linnaeus based the system of naming plants and animals, the fundamental principle of that philosophy being the postulate that the same species shall have the same trivial name in science everywhere on the globe, a law of Nomenclature on which there is now general agreement among Biologists. This fact afforded me consolation during the years of the interruption of international communications. For, if scientists can agree on one point, they will agree on others which are equally rational and desirable, a thought that awakens in our mind the possibility, and creates the hope, of general agreement on matters that deeply affect the welfare of mankind. I remained confident that even the inhuman provocations and continuous propaganda of the war years would not be able to extinguish the light of aimiable reasonableness which burns in the breast of the student and lover of Nature. We Entomologists are lovers and students of Nature, many of us having remained faithful to the love of our schooldays, and it was therefore no surprise to me that the members of the Executive Committee received 1947 with whole-hearted approval the news that our Swedish colleagues were going to invite the VIIIth Congress to meet at Stockholm in August 1948. The President elect of the Congress was my old friend Professor Yngve Sjöstedt, to whom my letters about the Congress were addressed before and after the war. His death was a great shock to all of us. But the preparations for the Congress were made and so it was to be *Le roi est mort, vive le roi*. On very short notice Professor Ivar Trägårdh took over the duties as President, and here we are now assembled under him, a multitude of Entomologists from many lands, happy and proud to breathe for a short while the air of the country in which Linnaeus lived and worked.

The Executive Committee has undergone several alterations since the first Congress in 1910, and the great change in the conditions of life since the VIIth Congress in 1938 suggests that it might perhaps be advisable to enlarge the Committee in order to bring it in closer touch with the various expanding branches of Entomology pure

and applied. We took no steps in this matter, because meanwhile UNESCO (United Nations Educational, Scientific and Cultural Organisation) had been created and we hoped that our Committee would have the benefit of the advice of UNESCO. On receipt of a letter from the Secretary of IUBS (International Union of Biological Sciences), a Division of UNESCO, asking whether the Executive Committee of the International Congresses of Entomology would agree to become a Section of IUBS, the members of the Executive Committee and other Entomologists of international standing were asked for an opinion. As expected some fear was expressed that organisation from above would tend to curtail the freedom of science. Further information, however, convinced us all that the object of IUBS was the same as that of our Congresses: collaboration of the individual workers. The Executive, therefore, unanimously voted in favour of becoming a Section of IUBS, with the proviso that the VIIIth Congress confirmed this decision.

In order to simplify the secretarial work in such a large Union as IUBS, comprising all branches of Biology, a certain degree of uniformity of organisation in the various Sections of the Union is required. The Executive Committee of our Congresses has no President. During a Congress the President of the Congress takes the chair at a meeting of the Executive Committee. I propose in the name of the Committee that this Meeting elect as President of the Executive Committee Professor René Jeannel, of the Muséum National d'Histoire Naturelle, Paris.

Another change in the Executive Committee will be placed before the last General Meeting. Old age compells me to hand the secretaryship over to a younger man. During the present Congress Mr. N. D. Riley will act instead of me, for which I am very grateful to him. The Entomological Congresses have survived the great shocks of two world wars and firmly established themselves as periodical gatherings of workers in Entomology. May their influence on collaboration always be on the increase and assist humanity to arrive at a state of peace and contentment. I have been present at all the previous Congresses and am very happy to be able to attend also the VIIIth Congress. Sweden has always attracted me greatly on account of the many important entomological publications which a taxonomist like myself has to consult almost daily.

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## Dr R. JEANNEL

Laissez moi d'abord remercier les organisateurs de ce Congrès pour l'honneur qu'ils m'ont fait en me chargeant de prendre ici la parole au nom de tous les délégués présents à ce Congrès. Sans doute vous êtes-vous souvenu des relations d'amitié qui ont lié votre grand suédois Linné, et aussi Fabricius, avec les maîtres de l'entomologie française de la fin du XVIII<sup>e</sup> siècle. Sans doute aussi avez-vous pensé à notre Muséum national d'Histoire naturelle, que j'ai l'honneur de représenter aujourd'hui, et qui fut illustré par Lamarck, fondateur de la doctrine de l'évolution et de la classification des Animaux sans vertèbres, ainsi que par Latreille, le père de l'entomologie moderne, auquel un de vos compatriotes, Dalmann, avait conféré le titre de "Prince de l'entomologie".

Je veux croire que, si vous m'avez choisi, c'est comme modeste successeur, dans la chaire d'entomologie du Muséum, de Lamarck et de Latreille, qui n'appartiennent pas seulement à la France mais au monde scientifique tout entier.

C'est donc au nom de tous les entomologistes présents à ce Congrès que je prends la parole aujourd'hui. Nous sommes ici les délégués de plus de 30 nations, et parmi nous se trouvent les représentants les plus notoires de notre science. Après la grande tourmente qui vient de bouleverser le monde, nous sommes heureux de nous trouver réunis à Stockholm pour reprendre notre collaboration pacifique, trop longtemps interrompue.

Au nom de tous, je veux tout d'abord adresser au Gouvernement de la Suède nos remerciements chaleureux pour avoir accueilli notre VIII<sup>e</sup> Congrès dans la belle ville de Stockholm. C'est pour nous une grande joie de nous trouver dans cette Suède, universellement aimée par tous les pays civilisés, où nous trouvons un modèle d'organisation civique et de bien-être. Tous ceux d'entre nous qui viennent de pays se relevant à peine de leurs ruines, respirent chez vous une atmosphère dont ils étaient, hélas, privés depuis près de dix ans. Grâce vous soit rendue de nous donner ainsi l'occasion de cette cure de quelques semaines particulièrement réconfortantes.

Je dois aussi, au nom de tous nos collègues étrangers, remercier particulièrement le Secrétariat général du Congrès et son chef M. Frankel, pour l'ordre et l'obligeance qu'il a mis dans l'organisation de notre réunion. Si parfois nous l'avons harcelé de questions, si nous n'avons pas toujours été assez ponctuels dans nos démarches administratives, nous avons cependant toujours trouvé auprès de lui une bienveillance et une cordialité que nous avons hautement appréciées. Je suis bien sûr que tous ici se joignent à moi pour le féliciter du travail accompli et le remercier chaudement.

Monsieur le Président, c'est le professeur Y. Sjöstedt que nous devons trouver ici à votre place. Sa haute réputation acquise par ses travaux entomologiques, ses splendides explorations du Kilimandjaro l'avaient naturellement désigné à la présidence de notre Congrès. Vous avez eu la douleur de le perdre, il y a quelques mois, et votre deuil a été ressenti par tous les entomologistes du monde entier. C'est donc vous, M. I. Trägårdh, qui avez été appelé à prendre sa place et nul choix ne pouvait être plus apprécié. Systématicien de la bonne école, spécialiste universellement connu par vos travaux sur les Acariens, vous avez acquis des titres nouveaux à la reconnaissance de votre pays et aussi le l'entomologie mondiale, en vous attachant depuis de nombreuses années à l'organisation de l'entomologie forestière en Suède. J'ai eu moi-même, comme bien d'autres, à me réjouir de vous voir collaborer à mes travaux, lorsque je vous ai



confié l'étude d'Acariens cavernicoles. C'est donc pour moi un plaisir de vous parler au nom de tous nos collègues étrangers et de vous saluer comme président de notre Congrès.

Tout entomologiste ne peut aborder en Suède qu'avec un sentiment de profond respect. Lequel d'entre nous n'a pas ressenti une certaine émotion en se trouvant dans la patrie de Linné.

Né à Råshult, dans le Småland, le célèbre professeur d'Upsala a été le génial fondateur de la Botanique et de la Zoologie modernes. La place qu'il occupe dans l'histoire des sciences égale celle des plus grands initiateurs, tels que Newton, Darwin ou Pasteur. Car c'est à lui que nous devons non seulement la nomenclature binominale, base de toute la systématique, mais encore le premier exposé des classifications naturelles, présenté avec clarté et une méthode scientifique rigoureuse.

La première ébauche de son "*Systema Naturae*" a été publiée en Hollande, mais toutes les éditions successives, jusqu'à la douzième, ont paru à Stockholm. Et il n'est pas besoin d'insister sur le caractère fondamental de cette œuvre magistrale, universellement reconnue comme le premier état de nos connaissances en sciences naturelles. D'un commun accord, tous nos congrès ont choisi la dixième édition de 1758 comme point de départ de toute recherche de priorité.

C'est encore à Stockholm qu'ont paru les "Mémoires pour servir à l'Histoire des Insectes" de De Geer, émule de Reaumur, auteur de la première classification des Insectes faisant état des pièces buccales. Et Fabricius, danois d'origine, fut un élève assidu de Linné et a honoré en cela la Suède. Observant le parti heureux que son maître avait tiré des dents pour la classification des Mammifères, il reprit les idées de De Geer et conçut un système entomologique uniquement basé sur les organes correspondant chez les Insectes. Son "*Entomologia Systematica*" consacre cette classification. D'autre part, imitant la "*Philosophia Botanica*" de Linné, il a écrit une "*Philosophia Entomologica*" qui peut être considérée comme le premier fondement de la zoogéographie.

Que d'autres noms fameux à évoquer dans l'entomologie suédoise. C'est Dalman, contemporain de Fabricius, inspecteur du Muséum de l'Académie, puis, au XIX<sup>e</sup> siècle, Thunberg, successeur de Linné comme professeur à Upsala, Boheman, intendant du Muséum de l'Académie à Stockholm, Gyllenhal, élève de Linné, Schönherr, Paykull, Stål, et bien d'autres. Gyllenhal et Paykull ont donné chacun une "*Fauna Suecica*". Boheman s'est illustré par ses "*Insecta Caffraria*" et de nombreux ouvrages sur les Hyménoptères, les Coléoptères et les Hémiptères; Schönherr par sa "*Synonymia Insectorum*" et ses études sur les Curculionides; le Dr Stål, de Stockholm, par d'admirables travaux sur les Hémiptères, les Orthoptères et les Coléoptères. On pourrait en citer bien d'autres qui furent d'excellents entomologistes au cours du siècle dernier.

Je ne puis parler ici des modernes. Ils sont les dignes successeurs des anciens. Après des spécialistes réputés, comme Aurivillius et Sjöstedt, qui ne sont plus, il existe actuellement en Suède, une admirable école de naturalistes particulièrement orientés vers le côté biologique de l'entomologie. Je ne veux pas citer de noms, pour ménager la modestie de personnes qui sont ici présentes; mais je pense aux excellents travaux qui ont paru sur l'entomologie forestière, sur les espèces boréoalpines, sur la faune de l'Islande, et aussi au remarquable Catalogue des Coléoptères du Danemark et de la Fennoscandie, qui vient d'être édité à Helsingfors.

Tous vos travaux, mes chers collègues suédois, sont marqués au coin du plus bel esprit scientifique, comme d'ailleurs tous ceux des autres pays scandinaves; Et la belle

présentation de vos publications ne laisse pas de provoquer l'admiration et aussi, dirai-je, l'envie des entomologistes des pays, comme le mien, où les difficultés économiques actuelles paralysent par trop l'impression des travaux scientifiques.

Certes, je sais bien que vous devez avoir aussi, en Suède, les mêmes difficultés financières que celles qui limitent la production scientifique dans tous les pays. Cette crise que nous subissons tous est d'autant plus fâcheuse pour l'entomologie que le nombre des travaux s'accroît partout, à mesure que notre science se développe.

L'entomologie n'est plus aujourd'hui ce qu'elle était du temps de Linné ou de Fabricius. Elle s'est immensément étendue dans toutes ses branches d'application. Et je suis sûr que notre Congrès va en apporter la démonstration.

La protection des plantes cultivées et des forêts contre les Insectes nuisibles a rendu nécessaire la création de puissants Instituts de recherche, où l'étude de la biologie des Insectes est poussée jusque dans les plus petits détails, afin de découvrir les meilleures méthodes de lutte. Sous l'impulsion de ces Instituts, l'écologie, science des conditions d'existence des être vivants et des interractions entre eux et le milieu vital, a pris un essor considérable. D'autre part, cette nécessité de détruire les ravageurs a eu comme corollaire le développement d'industries chimiques et de laboratoires expérimentant l'action des insecticides. Il a fallu aussi mettre en œuvre tous les moyens modernes pour répandre efficacement ces derniers. La guerre contre les Insectes est conduite aujourd'hui comme celle contre les humains, avec lances-flammes, gaz asphyxiants et même avec l'aide de l'aviation. L'Amérique a donné au monde l'exemple d'une entomologie appliquée parfaitement organisée dans ses Instituts de recherche et soutenue par une législation adéquate. L'Angleterre, la Belgique, la France, tous les pays colonisateurs tendent aujourd'hui à suivre l'exemple des Américains.

L'entomologie médicale et vétérinaire a fait aussi de grands progrès. Trop d'Insectes des pays chauds sont des vecteurs de maladies qui déciment les populations : malaria, maladie du sommeil, fièvre jaune et bien d'autres. Toute une branche de l'entomologie, dans des Instituts spéciaux, se consacre à l'étude des Diptères, des Acariens et autres Invertébrés qui hébergent les agents pathogènes pour l'homme et les animaux domestiques.

Dans un autre ordre d'idées, moins directement utilitaire, l'entomologie s'est encore particulièrement étendue du côté de la biologie. Même chez les entomologistes amateurs, le nombre des collectionneurs, simples piqueurs d'Insectes, diminue au bénéfice de ceux qui préfèrent avant tout observer le mode de vie des espèces dans la nature. Il en résulte un nombre considérable d'observations très utiles et souvent très bien faites.

En même temps, dans nos laboratoires, les recherches s'orientent de plus en plus vers la biologie. Les études portent sur l'éthologie des Insectes, sociaux ou autres, sur l'écologie, sur la physiologie et la psychologie expérimentale; sur la biométrie, où les disciplines mathématiques s'emparent de la morphologie. Dirai-je enfin la génétique, pour laquelle tant d'Insectes sont devenus les plus précieux animaux de laboratoire.

Comme on le voit, la place prise aujourd'hui par les Insectes dans la Zoologie est devenue considérable. Il fut un temps, pas très éloigné, où les animaux marins étaient à peu près seuls à provoquer l'intérêt des zoologistes. Aujourd'hui, de plus en plus, l'incroyable diversité du monde des Insectes attire les chercheurs, et leurs travaux ne cessent d'accroître nos connaissances dans toutes les directions. Mais je veux terminer ce discours par un appel en faveur de la systématique. On néglige aujourd'hui beaucoup trop la systématique.

D'une part, une bonne systématique est nécessaire comme base de toute recherche biologique ou appliquée. Tout entomologiste, quelle que soit sa formation, doit être un bon systématicien. D'autre part, il ne faut pas croire que la systématique soit restée une science aride et fastidieuse. Elle est au contraire pleine d'intérêt et riche en généralisations, si on la considère, comme elle doit l'être, en tant que phylogénie appliquée.

Depuis que la doctrine de l'évolution régit toute recherche scientifique, la vraie systématique est devenue en quelque sorte une science historique.

Les espèces dont nous disposons doivent être étudiées en fonction de leurs rapports de parenté. L'analyse raisonnée des conformations anatomiques doit faire découvrir chez elles d'une part des caractères néogénétiques acquis au cours de leur évolution, d'autre part les caractères de filiation, paléogénétiques, décelant une origine commune. Ainsi se dégage la notion de lignées naturelles d'espèces proches parentes, et ces lignées sont la véritable unité biologique dans la nature actuelle. C'est par la connaissance de ces lignées que doivent être élaborées nos constructions systématiques de genres, tribus, familles.

Il est vrai que de telles recherches sont longues et laborieuses; elles comportent beaucoup d'analyses et des descriptions accumulées dans de copieuses monographies. Mais une fois le travail accompli, le systématicien se trouve en possession d'éléments précieux qui lui permettent de comprendre la répartition géographique des espèces et de reconstituer l'histoire des lignées dans le passé géologique.

Les Insectes sont un matériel particulièrement favorable pour de telles recherches. On sait qu'ils sont les plus anciens occupants des continents terrestres, et leur généalogie remonte jusque dans l'ère primaire.

Ainsi comprise, comme science historique, la systématique des Insectes devient la base solide de toute étude de Biogéographie. Elle concourt, autant que les sciences géologiques, à faire connaître l'histoire des continents terrestres. Toutes les reconstructions paléogéographiques qui en découlent l'élèvent bien au dessus d'une aride classification d'espèces.

Mais je ne veux pas abuser davantage de la place que j'occupe en ce moment pour exposer devant vous des idées personnelles. Je dois rester dans mon rôle de porte-parole des délégués étrangers. Et je termine en renouvelant à nos collègues suédois l'assurance à la fois de notre plaisir de nous trouver en Suède et de notre confraternelle sympathie.

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## ENTOMOLOGY IN LUND, ITS HISTORY AND PRESENT STATE

By *Kjell Ander*

The university of Lund was founded in 1668, only a few years after the province Skåne (Scania) had been captured from Denmark. Compared with numerous universities in England and on the continent Lund University thus is rather young.

At the new little university there was for a long period no teacher in natural history. Not till 1728 was there any professor to lecture in zoology at all, and then only as a subordinate subject. Kilian Stobaeus, later rector of the university, was the first to give this teaching. He is reckoned among the great men of the university and you will see his bust before the university building. Whether he lectured in entomology is not known. He has also renown as the teacher of the young Linnaeus, who in 1727—28 studied in Lund. During this year Linnaeus lived in Stobaeus's house and was allowed to study his library and his collections. Stobaeus was, as all naturalists of his time, also a physician. During his time as rector he gave in 1735 all his collections, both natural history specimens and ethnographic, to the Academy. He thus founded the Zoological museum and at the same time the present entomological museum. As a sign of gratitude for this gift the Academy had the memorial tablet, which you see in this lecture hall, made.

The Stobaeus collection contained about 300 preparations of insects. They were prepared between two pieces of glass, an old method. It contained chiefly Swedish insects and only a few larger tropical ones. It is sometimes said that Linnaeus had an opportunity to study this collection. However, recent studies in the archives have unveiled that the insects were collected some years after Linnaeus left Lund. Only about 80 specimens are now left. As far as I know this is the next oldest still existing insect collection. The oldest is the Petiver collection in the British museum in London. It is interesting to note that Petiver's insects were prepared in the same method as Stobaeus's as fig. 79 in Bodenheimers *Geschichte der Entomologie* shows.

Our museum also possesses another old collection from the eighteenth century. Here every insect is enclosed in a little box with a glass cover and a glass floor.

After Stobaeus there came a period without any great interest for zoology at the university. Everything was concentrated to Linnaeus at Uppsala. In 1853 one of his pupils, E. G. Lidbeck, was professor in Lund. He was also director of the so-called mulberry plantation in Lund. An attempt was made at that time to cultivate silk in Sweden and not totally in vain, as a sample in our museum will show you. The museum also possesses a silk brocade made of local silk in Lund. Lidbeck also brought together a collection of pinned insect which has long since been totally destroyed.

In 1787 Anders Johan Retzius was professor of natural history, the first professor in this subject. He also belongs among the great men of the university. Although he published two papers on entomology, he didn't care much about the entomological collections. Two of his pupils, Fallén and Zetterstedt, became prominent entomologists. The first mentioned, Carl Fredrik Fallén, succeeded him as professor. He possessed large private collections of insects and published a great number of papers on Swedish insects, especially Diptera and Hemiptera. We look upon him as the first great entomologist of Lund. If he is not much known outside Sweden, it is because he only studied Swedish insects. But it was just with these studies that he founded the Lund

tradition in exploration of the Swedish fauna. All Fallén's collections were given to Zetterstedt by his widow. With the exception of the Diptera, which Zetterstedt gave to the Natural History museum of Stockholm, his collections are now in Lund. Apparently Fallén didn't take much care of the old collections. He lived in his farm, Esperöd, in Eastern Scania except during the terms when he lectured in Lund. Fallén died 1830. His successor was Sven Nilsson, a prominent zoologist and archeologist, but not at all interested in insects. On the contrary he worked against the entomologists. In spite of this entomology flourished in Lund. This was due to two people, the already mentioned Johan Wilhelm Zetterstedt and Dahlbom. The former was a pupil of Retzius and Fallén. We look upon him as the second of the great Lund entomologists. He was demonstrator of botany, to use the Swedish title, until 1839 when he was appointed professor of botany. However his chief interest was in the insects; as a botanist he was very insignificant. His scientific work in entomology is indeed important. He was a central person in Swedish entomology at that time and amassed a very large number of insects, for in addition to his vast Swedish collections he also made a comprehensive one of exotic forms. The museum has 9 cabinets which belonged to him. All his collections are preserved in Lund. Zetterstedt continued the exploration of the Swedish fauna with the utmost success. He undertook two expeditions to Lapland. This country was at that time a nearly primeval land with few Swedish settlements. The entomological results of these expeditions were published in *Fauna insectorum Lapponica*, 1828, and *Insecta Lapponica*, 1838—40, both still very important books. Of the numerous trips to other parts he undertook, especially may be mentioned those to the Baltic islands Öland and Gotland, during which he discovered some of these southern insects which are in Sweden restricted to these islands or have their main distribution there. In the books mentioned all winged orders are dealt with, and every species known as occurring in Northern Scandinavia is described. Zetterstedt's "Lapponia" comprises not only Lapland but the northern interior part of Sweden, Northern Norway including the high mountains in the central parts as well as northern Finland. In *Insecta Lapponica* he divides the species to different regions, *regio sylvatica*, *subsylvetica*, *alpina* et *interalpina*. He thus may be considered as our first entomogeographer. In this connection I will mention that Zetterstedt labelled his insects in most cases with locality and date, a method which was earlier unknown and later considered unnecessary. He continued Fallén's studies on Diptera, and his second great work is his famous *Diptera Scandinaviae* in 14 volumes. This work is still of such importance, that the great bookpublisher Junk once intended to publish a facsimile edition of it. All Zetterstedt's collections are in Lund.

The third great Lund entomologist was Anders Gustaf Dahlbom. He was a near friend of Zetterstedt and his companion on several journeys. In 1843 he was appointed lecturer (Swedish: adjunkt) of entomology and curator (Swedish: intendent) of the entomological collections at the university. Ever since then there has been a teacher in entomology at Lund university, that is to say for more than 100 years. It was not until last year 1947 that a corresponding position was erected at the Uppsala university. Dahlbom was a very clever scientist and devoted himself to the study of the Hymenoptera, especially the Aculeata and Phytophaga. His main work is *Hymenoptera Borealia* in two volumes (1845—54). He also understood the economic importance of insects and published in 1838 the first Swedish handbook in applied entomology. Dahlbom was, as I said, curator of the collections. With them as a basis he founded the Entomological museum. The older collections were rearranged and catalogued,

and new ones were acquired. He undertook several journeys to England and the continent, he was f.i. in Paris where he also studied the apes and monkeys. I do not think I am mistaken, when I assume that it was with the credit from such studies that he hoped to be appointed to the chair of zoology, soon to be vacated by the retiring prof. Nilsson. Fortunately his own position was in 1857 changed to a professorship of entomology. Entomology now had won a very strong position at our southern university. The favourable development in Lund was suddenly broken by the death of Dahlbom May 1859, for the professorship was then withdrawn. It lasted two years until a new teacher of entomology was appointed with the position of lecturer. He was Carl Gustaf Thomson, the pupil of Dahlbom, and he had worked in the museum for some time. He is the fourth of the great Lund entomologists and the most celebrated of them all. He was endowed with a remarkable systematic talent which enabled him to solve difficult taxonomic questions with only the use of hand lenses. His knowledge covered all insects; he has published papers on Orthoptera, Hemiptera, Trichoptera, Lepidoptera, Diptera and especially Coleoptera and Hymenoptera. It is primarily as a hymenopterist that he has won renown. It was the most difficult groups, the parasitic Hymenoptera he especially took up for study. Thomson worked mainly with the Swedish insect fauna and his contributions are still of the utmost importance in this field. His main works are *Coleoptera Scandinaviae* (1859—68) and *Hymenoptera Scandinaviae* (1871—78) as well as his series *Opuscula Entomologica* in 22 parts (1869—95). In this series he collected a large number of his scientific studies. He was more an investigator than a curator, and his interest in curatorial matters appears to have been minor. He was however an inspiring teacher as one of his pupils, dr. Bengtsson has related for his own pupils. Thomson was admired by his friends and pupils for his genius and his immense knowledge but through his sprightly temperament he also made enemies. His collections were purchased by the university, but unfortunately he had already sold a large collection of Coleoptera to Germany and it is now in the Berlin Museum. During his last years his power of sight diminished rapidly and at his death in 1899 he was blind.

With the death of Thomson entomology in Lund entered a new phase. The post of lecturer in entomology was withdrawn completely. It is true that dr. Simon Bengtsson was engaged as teacher in entomology and curator of the collections but on a footing so insecure that he had to gain a living by teaching in a private high school. It was not until 1918 that a new permanent teaching position in entomology was established, and Bengtsson was appointed to this post. Bengtsson was, as I said, a pupil of Thomson, whom he admired highly. He was my first teacher in entomology, and I am very grateful for his well prepared lectures on morphology, taxonomy and general entomology. Unfortunately Bengtsson was already 58 years old when he took up the appointment and this was one of the causes why he was not able to do much for the department. Personally he was an extremely kindhearted and noble man. He retired in 1929 and died 1939.

Dr. Bengtssons successor was Dr. Nils Kemner, one of his pupils, who had been at one time an assistant at the department for a few years. Thus the entomological traditions from the beginning of the nineteenth century until the present day have been handed down in an unbroken line from teacher to pupil. Certainly this has been a strength in the Lund entomology. With Dr. Kemner the department acquired a prominent leader who strongly championed its interests. At that time there was at the department no salaried assistants (Swedish: amanuens), nor any preparator. With

indefatigable energy and great initiative power he began immediately to modernize and enlarge the museum. New cabinets were procured, the accumulated material of Swedish insects was arranged in new collections after new principles, but the largest part of the collections acquired were made in the field by himself and his pupils. He used to take his car full of students, and then we used to drive to different parts of Skåne for collecting. He himself undertook in his car long journeys to all parts of Sweden. Through his enthusiasm, his humour and his friendliness he attracted many young men from among his students to work in the museum simply for the joy of taking part in building it up. Very soon the museum showed a new face. It was enlarged with a new room and files of new cabinets with tight drawers, a large exhibition collection etc.

Particular stress was laid on the Swedish collections as before in Lund. But also the exotic forms were partly arranged. Of course the new Swedish collections are not completely arranged. This has been an impossibility with the unsalaried and in many cases untried assistants. During the war some of the young men always were in military service, in 1940 nearly all of them. From these causes there is still much to be done arranging the new Swedish collections. Through Dr. Kemner's efforts the department soon got at first one salaried assistant, and two years ago three more, and a laboratory technician. At last he succeeded in having his position changed to a permanent professorship in entomology. The parliament decided this at the same time as he became ill, and the change of the position was then postponed. In 1940 he got, however, the title professor *honoris causa*.

An entomological department also needs a library. Prof. Kemner was very active in procuring journals and books for the library which to day is quite comprehensive. As a teacher he was very stimulating. And during his time 8 theses for the doctorate have been published.

Prof. Kemner's importance for Lund entomology and for Swedish entomology in general has indeed been very marked. At the side of Dahlbom, the founder of the museum, he must be named as the great organizer of the department. He died May eighth this spring. The Lund entomologists saw in him a prominent fearless leader who strongly maintained the importance of the science of entomology and at first hand looked after the interests of his department.

You have already some idea of the organization of the department. The director is in charge of the museum and teacher of entomology. There are four salaried but not permanent assistants of four degrees and a few unsalaried ones. Some instruction is also given by the docents at the university.

Some words about the collections may be added. The old collections of Fallén, Zetterstedt, Dahlbom, and Thomson are all kept separate, and they are kept in their original state although they have in some cases been moved into new drawers. All the specimens are there as none have been given away. The modern Swedish collections are arranged from a zoogeographical point of view beginning from the south to the north. We have striven for series of each species to allow studies of variation, but first to get as many as possible of the Swedish species represented.

The general collections are small, only a few groups have been arranged and in most cases they are not critically examined. As the museum began to be a modern museum with the appointment of prof. Kemner, you may understand that the greatest part is still to be done.

The Entomological Society of Lund works in close collaboration with the department. The society was founded 1903 on the initiative of dr Bengtsson, who was chairman until 1929. It is the meeting place of the entomologists of Scania. The meetings are usually held 8—10 times each year. An important function of the society is the registration of the insects of our province Skåne. In 1936 the society started the periodical *Opuscula entomologica*, which was given that name in honour of Thomsons publication with the same name. It was daring of the little society to start a journal. It was on the initiative of Prof. Kemner, and he managed to solve the economic question until a public grant was secured. In 1940 the Society started its most comprehensive and difficult task, the catalogue of the Swedish insects of which eight volumes are published to date. This great undertaking requires the cooperation of all Swedish entomologists and is indeed a very difficult one. Need I say, that professor Kemner also here took the initiative.

From what I have said you may have learned a little about the entomologists of Lund and entomological research here. You have seen that there has been dark and bright days in the history of Lund entomology. Very dark was this spring through the loss of our prominent leader professor Kemner, whose works shall speak more eloquent of him than I. To day, however, we see a brightning. It is you, honoured guests, who have caused this brightning when you assembled here in old Lund. Indeed, this day is one of the greatest in the history of Lund entomology. Entomologists from numerous nations, from four continents are today in Lund. You have come to learn something about Lund entomology at its own hearth, to see these things originating from our old predecessors, the founders of Lund entomology, the collections of Fallén, Dahlbom, Zetterstedt, and Thomson and, the more than 200 years old relics of the Stobaeus collection.

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## PROF. DR. LUNDBLAD

When the members had arrived in front of the buildings, Prof. Dr. Lundblad uttered:

"I am very sorry that I must tell you that Dr. Uggla, who has promised to give a lecture about Linnés Hammarby, is still in England. This may be considered a great drawback because Dr. Uggla knows everything about Hammarby much better than I. Anyhow, I'll try to do my best and to give you some few details about the buildings you are going to see here.

Linnés Hammarby was bought by Linnaeus in 1758 and was used as his country home during 20 years until his death in 1778. After that time the house was inhabited by his widow and after her death by other relations. From 1879 Hammarby belongs to the Swedish State and to the University of Upsala.

The original house, bought by Linnaeus and used by him and his family at the beginning, is that one to the left, whereas the main building was built by Linnaeus himself in 1762.

In the park Linnaeus planted a lot of foreign plants, many of which still grow there. In the garden you will still find that two trees have survived since Linnaeus' times, namely the Siberian appletree, *Pyrus baccata*, in the middle of the garden, and the veichsel, *Prunus mahaleb*, at the edge of the house.

You may already know that Linnés Hammarby once was the centre for the study of natural history not only here in Sweden but also for foreigners who came here to see Linnaeus and his collections and to listen to his lectures in the summer. The students lived in the neighbouring farms. On the top of the hill beyond the houses he built a museum in 1769, where he placed some of his more important collections in order to give them a safer place than in Upsala, viz. those of minerals, plants, molluscs, and insects. There you will also see the desk from which he held his lectures and which is still preserved as well as the benches for the audience.

As to the furniture in the dwelling-house I want to say that most of it is original, especially in the both rooms where Linné himself lived, his study and his bedroom. There are also many other things from the time when Linné inhabited the house."

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## FINAL SPEECH BY THE PRESIDENT OF THE CONGRESS

During the 38 years which have elapsed after the first meeting in Bruxelles 1910 there ought to have been about 12 international congresses, the intervals between them being generally three years, if conditions had been normal. But conditions have not been normal and as a consequence only seven congresses have been held. Between the second congress in Oxford and the third in Zurich 13 years passed, which means a loss of ten years, and between the seventh congress in Berlin and the eighth in Stockholm ten years have elapsed. This spells a loss of altogether 17 years.

Perhaps it may seem an exaggeration to speak of 17 years as being lost. And it is true that the development of entomology does not depend on the holding of congresses, because the work of the entomologists goes on uninterruptedly everywhere, congresses or no congresses.

But, on the other hand, we cannot shut our eyes to the fact that congresses are bound to play a very important part in the evolution of our science. Specialists on the same groups, perhaps living in different parts of the world, are brought face to face, problems are ventilated and ways or means of investigations discussed.

This is one side of the activities during a congress. But there is also another side which must not be underestimated. It is, I believe, the general experience of the entomologists, that the layman, the man in the street or, as we call him in Sweden Mr. Middleswenson, knows next to nothing about the purpose of entomological investigations. This is a deplorable state of things, not for the entomologists, most of which do not care about peoples' opinion of them, but for Mr. Middleswenson himself, because even a little knowledge about the activities of the nefarious insects would be useful to him.

The only way to alter this state of things is of course to enlighten the people about economic entomology.

I know that many scientists detest this way of thinking and consider it degrading to cater for this need of instruction by publishing popular books on natural science. But, fortunately, this attitude of mind now mostly belongs to the past.

As a matter of fact many of our most prominent scientists have been masters of popular science. Thomas S. Huxley, his grandson Julian Huxley, Haldane, Poulton, Carpenter, Imms, Ford and many other in England have enriched the mind of common people by their masterly treatment of biology, Wesenberg-Lund in Denmark, Escherich in Germany, Forel in Switzerland, Handlirsch in Austria, Fabre and Jeannel in France are examples of the same kind. And as to U.S.A. they are so numerous that only a few can be mentioned, Howard, Comstock, Wheeler, Brues and many others.

But to return to the congresses, it has been my experience, and I have been fortunate enough to attend to five congresses before this one, that they have enjoyed a great publicity in the newspapers. Not because the journalists are interested in insects, but because the holding of an entomological congress makes entomology the topic for a few days. And the journalist love to write about the topics of the day. If the bureau of this congress knows its business it will provide the press with extracts of the proceedings and we may expect to read about what we have been doing without any disfiguring errors. Thus some knowledge about entomology may be disseminated.

But the best way to rouse the interest of the laymen in our activities is of course

to appeal to their most fundamental trait, their egotism, and make them realize that the insects constitute a growing danger to their welfare and economy.

For this purpose I have culled a few data from a recent publication, published this spring. Even to the most hardened economic entomologist the following figures seem stupendous although they only refer to the losses caused by the insect pests of stored products. In 1946 a conference of experts convened in Washington by the U.S. Food and Agriculture organization estimated that the overall losses to cereals and cereal products amounted to 5 % of the crops harvested. This may not sound very impressive, but if we add that if this loss could be prevented it would mean that the United States would be able to double their export to the deficiency areas, the problem assumes its true proportions.

In hot countries, such as India and Java, the activity of these pests are even worse. It is estimated that the storage life of rice in India is only 8 months before it becomes unfit for human consumption. It is also estimated that, if we only calculate with a loss of 2,5 % per annum, the amount eaten by the insects spells the deprivation of four million of people of their food during one year.

I think we must all agree that these conditions are appalling. And yet these data refer only to one side of the activities of the injurious insects.

Twenty years ago, at the fourth international congress in Cornell university, the grand old man, L. O. Howard in his presidential address stressed the point that it was a vain boast when man considered himself the master of this earth. The real masters of the earth were the insects. Mans' ascendancy to this exalted position depended entirely upon his ability to cope successfully with his foes, the insects.

We may well ask, how far we have advanced since Howard emphasized the dire necessity of fighting the injurious insects. Have we made any advances at all? It is true that certain great achievements have been recorded, campaigns which in the beginning seemed doomed to failure have succeeded far beyond our most audacious expectations.

But these bright spots in the picture are, in my opinion, more than counterbalanced by deep shadows. We cannot shut our eyes to the fact that the danger from the insects is steadily increasing. Because it is in the nature of things that the obnoxious insects are furthered rather than hindered by the agricultural activities of man and in many other ways. I have already touched upon this very briefly in my presidential address. But yet another instance from the south of France may be quoted. Owing to the last war it was impossible to maintain the fire protection system practiced in the great pine forests of "les Landes". The result was catastrophic fires in the forests. The large burned areas were gradually invaded by a kind of tussock grass (*Molinia*). These grasscovered areas were evidently excellent breeding grounds for the locusts which started propagating and swarming and extending their range so that in 1947 an unusual number of locusts appeared in the southern England.

Thus the opinion of the 4th Antilocust conference in 1936 that the mass development of locusts and grasshoppers was furthered rather than hindered by mans activities proved to be only too true. In this instance the fires, converting of forests into grasslands, were the factor that started the trouble.

The food crisis is global and the danger to the health of mankind is also global and the only way to grapple successfully with these immense problems is a worldwide cooperation, between the governments and their experts, the entomologists.

Fortunately there has always been a splendid cooperation between the entomologists of the world. There exists a deep sense of partnership and mutual good-will between them which is a delight to behold.

When Howard started his campaign with the biological method against the gipsy moth in North America he spent during the years 1902—1912 every summer in Europe collecting parasites of the moth for introduction into the states. In France he was aided by Paul Marchal, in Italy by Silvestri and Berlese, in Hungary by Jablonowski, in Austria by Rebel, in Germany by Heller and in Russia by Portschinsky and Mokrszetsky. In truth a splendid teamwork, unhampered by any geographical or ethnological barriers.

Professor Karl Escherich from Germany was invited by the Scotch-American millionaire Andrew Carnegie to visit U.S.A. and study the economic entomology there. The money was well spent. Escherich wrote a very enthusiastic book about what he saw in America. And stimulated by his experiences he founded the "Gesellschaft für angewandte Entomologie" and a journal, "Zeitschrift für angewandte Entomologie". Both have fortunately survived the war. There is no doubt about that the raising of the economic entomology to its present high level in Germany is due to Escherich. But we must not forget that it was the result of the cooperation between Scotland, U.S.A. and Germany.

The trip across the pond made by Escherich dwindles, however, to next to nothing in comparison with the activities of my old friend Filippo Silvestri. Very likely he has lost count of how many times he has traversed the globe in search of either parasites of the fruit fly or of some other dangerous pest.

One of the greatest steps forward in fighting the injurious insects was taken when Dr. Guy Marshall was entrusted with the organization of the Imperial Institute of Entomology, which was closely associated with British Museum of Natural History. Now the institute is very aptly called the Commonwealth Institution of entomology and Dr. Marshall is Sir Guy Marshall.

Last but not least the activity of U.S.A. must be mentioned. The organization of the Society of economic entomologists and its journal has been of world-wide importance. And finally it is not possible to mention U.S.A. which have always been far ahead of Europe in economic entomology, without doing homage to the grand old man Rockefeller.

Many evil things have been said about the millionaires and they embody in the mind of certain political doctrines all the evil, considered to be inherent in those who have too much of the filthy lucre. We are not discussing politics here. But we can all agree that Rockefeller was worth many times his weight in gold.

He had the genial foresight to entrust to the philosopher Wicliffe Rose to carry out his intentions and his belief that the finding of truth and the whole-sale diffusion of knowledge would make mankind healthier and happier. It is surely superfluous to dwell on the stupendous activities of the Rockefeller foundation, the Rockefeller health commission and other affiliated organizations.

Every country, small or large, rich or poor has, without regard to race or religion, reaped immense benefits from this world wide organization. If, in these dark and sinister days we wish to rest our eyes on something which may stimulate an optimism without which life is not worth living, let us then dwell on the magnanimous feat of Mr. Rockefeller. I address this homage to all his compatriots here present.

When one starts making preparations for an international congress it is as if one started rolling a small snowball down the snow covered slope of a big mountain. The ball increases rapidly in size and becomes finally an avalanche threatening to suffocate the people who started the rolling of the snow-ball. If we, the organization committee, have managed to survive it is mainly due to the valuable assistance we had in this enterprise, so formidable for a small country.

We are very much obliged to

His Royal Highness the Crown Prince of Sweden

the Government, especially the Foreign Office and the Board of Education

the Prime Minister, the Town Council of Stockholm, the Town of Uppsala, the University of Uppsala, the University of Lund, the Chief of the Military School, the Head-master of the Östermalms school, some donators and industrial corporations, the Vice President, the General Secretary, the executive committee, the working committee, the ladies committee, Union Internationale des Sciences Biologiques, United Nations Educational, Scientific & Cultural Organisation, for all the help and the support we have received.

The last but not the least to be mentioned here is our secretary Dr. Albrecht Fraenkel. Although not an entomologist he has given us a wonderful help and if the Congress has been a success it is in the first instance due to his eminent capacity, his untiring labour and his unequalled resourcefulness.

We, your hosts, hope that this congress will stimulate all the participants to still further efforts to develop our science.

But quite apart from this general beneficial influence, let me assure you, our honoured guests, that the Swedish entomologists are deeply grateful for all the seeds of knowledge which you have so lavishly dusted over us, to use a current entomological term.

And, to conclude, I express the hope that you have had the opportunity not only of knitting old bonds but also of forming new bonds of understanding and friendship which everyone of us will in years to come treasure as something very precious to our hearts.

With these words I declare the eighth international congress of entomology in Stockholm finished.

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## C. J. BRIEJËR

The executive committee asked me to say a few words at the end of the Congress, on behalf of *all* foreign delegates.

I consider it a great honour to do so.

There has been a swarm of entomologists over this country, it was this time not an insect pest but an entomologist pest!

In one respect, however, this pest is very different from others: you need not kill them to get rid of them, they are going from their own free will and they are very satisfied and extremely grateful.

I must confess that I myself am not a real entomologist. Originally I was an applied entomologist, which as I understand sounds rather bad to taxonomists.

Today I am only an administrator which is still worse. Consequently I did not take the life of any of your Swedish insects, not even at Hammarby.

But I feel, that the insects were not the main item at this congress.

I consider of main importance the opportunity given to us to strengthen international friendship, coöperation and mutual understanding. Our world is not a very good world and there is much misunderstanding. In my opinion we scientists *can* and *must* contribute very much to international goodwill.

All delegates appreciate very much the enormous amount of work that their Swedish friends had to do to organize this congress.

In doing all this work you did not only contribute to entomology but also to a very great extent to international friendship.

It is impossible to mention all those who took part in this work.

We made a pilgrimage to Linné's house at Hammarby.—We stood some minutes at his grave in the marvellous cathedral in Upsala.—We lived for some hours in the 18th century in Drottningholm.—We visited many of your very modern and well equipped institutes.—We admired various remarkable and precious things in your museums.

For all this the visiting entomologists wish to express their most sincere thanks.

The ladies also I am sure enjoyed their trip very much.

Most certainly we are all leaving with great friendship in our hearts for Sweden and the Swedish people.

I hope very much that we shall not have to wait another 10 years to meet again but that we shall meet in some years in a somewhat improved world.

The Netherlands government which I am representing on this congress will esteem it an honour to receive you all in the Netherlands and I hope we shall be able to give you an equal good time as we had in Sweden.

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**G. L. van EYNDHOVEN:**

The Netherlands Entomological Society, of which I have the honour to be the Secretary, has elected this year as Honorary Members Prof. Dr F. S. Bodenheimer, Jerusalem, Dr Karl Jordan, Tring (England), Prof. E. Ségué, Paris, and Prof. Dr Ivar Trägårdh, Experimentalfältet (Sweden), and now that I have the privilege of meeting two of these gentlemen personally here in Stockholm, I should like to take the opportunity to say a few words in their honour.

Dear Prof. Trägårdh, just as the mites you are studying are creeping all over the world, so your scientific works have reached the most distant places of our good earth. Although the Acarina are favoured with your special attention, your name is well known to the greater part of all entomologists. So it has been a pleasure to the Board of our Society to propose you as an Honorary Member at our summer meeting of the 3rd July 1948, which proposal met with the fullest approval of all members.

Of course your nomination has nothing to do with this Congress, but the fact that you were appointed Vice-President, and after the death of your great compatriot, Prof. Sjöstedt, became President of the present Congress, sufficiently confirms that we made a good choice and that your own country as well considers you one of her most prominent representatives.

To me, as an acarologist, it is a satisfaction that after such scientists as Prof. Berlese and Dr A. C. Oudemans, once again an acarologist of world reputation appears in our list of honour.

The acarologists are few in number, and they seldom meet. So it has been a great disappointment both to you and to me that your duties in connection with the Congress forced you to return prematurely to Sweden from your visit to Paris. So this prevented you from being my guest in the Netherlands and we had to wait till this Congress before having an opportunity of meeting.

And, Dr Jordan, to you I could say much the same as to Prof. Trägårdh. I need not in this place emphasize your merits as an entomologist, for they are known to all of us. You may be proud that your publications, especially on the Siphonaptera, are of high international value, and that the great amount of work that you have given to the International Congresses of Entomology has greatly advanced the personal acquaintance, the friendship and the cooperation of entomological workers all over the world.

During a number of years you have been a correspondent of our Society and I know how kindly you are disposed towards her. So it has been a satisfaction to us to have been able to offer you an honorary membership.

My Society had made for each of you a *Diplôme d'Honneur* which I have taken with me to Sweden and which I now have the pleasure to hand you with the congratulations of myself and of all Netherlands entomologists.

## REPORT OF THE EXECUTIVE COMMITTEE

The Executive Committee of the *International Entomological Congresses* has, following precedent, briefly to report to the final full session of the 8th congress certain actions and decisions they have taken since the last congress in 1938 in the confident belief that the present congress will see fit to endorse these acts.

1. First, the committee has to report that Dr. Jordan has felt it necessary to resign the permanent secretaryship.

Dr. Jordan, whom we are all so delighted to have with us on this occasion, and who is the founder of all our congresses, has unquestionably done more than any other man to maintain the continuity of our congresses. His wisdom and charm no less than his eminence as an entomologist have endeared him to the hearts of all of us. The committee could not do otherwise than accept his resignation with feelings of the greatest regret. They are convinced, however, that this congress whilst endorsing this action would wish in some way to mark their high appreciation of Dr. Jordan's services both to Entomology and to the congresses.

Accordingly they recommend that Dr. Jordan be elected *Honorary Life President of the Congress and Honorary Life Member of the Executive Committee*.

2. Secondly, the executive committee has felt it very desirable that the congress should pay its respects to a limited number of distinguished entomologists in different parts of the world, who have taken an active interest in these congresses, by electing them *Honorary Life Members*. Accordingly they propose that congress should so elect

*Dr. Johannsen* of Cornell University, Ithaca, U.S.A.,

*Dr. Mac Gillavry* of Amerongen, Holland

*Dr. Karl Holdhaus* of Vienna and

*Dr. A. D. Imms* of the University of Cambridge, England.

3. Thirdly, the committee has given consideration to the desirability of adding to its numbers so as to achieve a wider territorial representation in keeping with its new responsibilities as the *Entomological Section of the International Union of Biological Sciences*.

Unfortunately, time has been too short during the course of the present congress to permit it to formulate a list of additional members. Accordingly the committee begs leave of the congress to increase its membership to a total not exceeding 18 by consultation with the entomologists of other countries.

4. Fourthly, the committee recommends that *Mr. Riley* be elected to the post of secretary to the executive committee rendered vacant through the retirement of Dr. Jordan, and automatically, to the secretaryship of the Entomological Section of the International Union of Biological Sciences.

Finally, I have to report that the committee has given earnest consideration to the various invitations received from countries wishing to be the seat of the next congress, due to be held in 1951. It has been mindful of the fact that it had been agreed that the congress due to be held in 1945 should take place in Holland in conjunction with the centenary celebrations of The Netherlands Entomological Society. They have, during the present congress been assured by their Dutch colleagues that this invitation is still a firm one, and accordingly they recommend that it be accepted.

There remains only one matter upon which the committee must comment:



The committee wishes it to be made abundantly clear that the success of every congress depends upon the organizing committee and *not* upon the executive committee. Members of congress will perceive, therefore, without any hint from them, to whom are due their thanks for the outstanding success of

THE 8TH ENTOMOLOGICAL CONGRESS.

*Stockholm, August 12th 1948.*

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## COMMUNICATIONS

### GENERAL SESSIONS

#### L'APICULTURE DE LA REGION LANDAISE (FRANCE SUD-OUEST)

Par A. Couturier

*Situation géographique et démographique. —*

L'originalité de l'apiculture landaise réside à la fois dans la flore particulière où les abeilles puisent tardivement leurs ressources et dans la manière primitive dont les exploitants conduisent leur rucher.

La région dite des landes forme un vaste plateau de 1.200.000 hectares s'ouvrant largement sur l'Océan Atlantique, de la pointe de Graves à l'embouchure de l'Adour, il se rétrécit progressivement jusqu'à Nérac qui forme le sommet de ce triangle géographique. Au nord, il s'étend jusqu'à l'estuaire de la Gironde et suit à distance la plaine alluviale de la Garonne. Ses limites naturelles sont marquées au sud par la Midouze et l'Adour aux confins de l'Armagnac et de la Chalosse.

Les influences océaniques se font surtout sentir au printemps et à l'automne généralement pluvieux; les hivers sont relativement doux.

La constitution du sol est assez particulière, les formations calcaires déposées autrefois dans le Golfe d'Aquitaine et dominantes dans les pays limitrophes, sont enfouies ici sous un épais manteau de sable venu les recouvrir au Quaternaire. Les eaux d'infiltration ont provoqué la formation d'un grès compact et quasi imperméable, appelé "alios", qui épouse les inégalités du sol à un niveau variant de 0m,60 à 1 m, au-dessous de la surface. Il en résulte une accumulation des eaux de précipitation dans les moindres cuvettes<sup>1</sup>.

Les nombreux marécages ont justifiés pendant longtemps la réputation d'insalubrité du pays, jadis dévasté par les fièvres. Les grands travaux de drainage et de plantations de pins (*Pinus maritima* Poir.), entrepris il y a une centaine d'années sous l'impulsion de Chambrélen<sup>2</sup>, ont assaini ce plateau désolé, tout en permettant l'exploitation de cette nouvelle source de richesse dans une région autrefois si déshéritée. L'écoulement régulier des eaux, en faisant disparaître une partie des marais où règne *Molinia caerulea* Moench, a favorisé le développement d'une lande sèche à flore très mellifère (*Calluna vulgaris* Salisb., *Erica cinerea* L.).

Ces transformations ont profondément modifié la vie du paysan qui vit toujours en isolé. La densité de population est très faible, elle atteint rarement 20 habitants au km<sup>2</sup> contre 71 de moyenne pour toute la France. Le métayer, gardien de moutons vulgarisé par l'image, a abandonné ses échasses pour devenir le "résinier" dont la vie se passe dans la forêt, allant d'arbre en arbre rafraîchir les entailles d'ou s'écoule la précieuse résine. Cependant, il ne prend pas plus de temps que naguère pour s'occuper des Abeilles, il se contente toujours de surveiller la sortie des essaims, pour les capturer et les loger dans un panier dans lequel la colonie se développera librement comme dans une cavité naturelle. A la fin de la saison le landais étouffera quelques ruches pour en retirer le miel.

<sup>1</sup> Arque P.: Géographie du midi aquitain — 269 p., Paris 1939.

*La flore et la travail des abeilles —*

Avant les incendies des dernières années, qui l'on réduite d'un tiers, la "pignada" couvrait une surface de 775.000 hectares.

Le pin donne très peu d'ombre, le sous bois est soumis durant le plein été à une très forte insolation et à une grande sécheresse. Sa flore diffère peu de celle de la lande, elle comprend plus particulièrement *Calluna vulgaris* Salisb. qui forme de vastes peuplements en association avec les Ajoncs *Ulex europaeus* L. et *U. nanus* Sm. et avec la "Brande" ou "Bruyère à balais" (*Erica Scoparia* L.). La Bruyère cendrée (*Erica cinerea* L.) apparaît dans les coins les plus riches et les moins arides, en particulier dans la région des lacs.

La Fougère aigle (*Pteris aquilina* L.) nuit au développement des Bruyères par son couvert trop dense. Autrefois la pâture et la coupe régulière du sous-bois, en vue de l'entretien des litières du bétail, empêchaient la "Brande" et la Fougère de prendre un trop fort développement aux dépens de *Calluna* qui dépérit souvent au-dessous.

La Bruyère cendrée fleurit en juin, juillet et août. Elle est très visitée par les abeilles qui en retirent un miel brun, fluide mais cristallisant facilement dans les rayons. Son goût particulier, assez âpre, est très apprécié par les gens du pays.

La Bruyère commune (*C. vulgaris* Salisb.) est encore appelée "Bruyère fine" ou "Petite Bruyère" par opposition à la "Cendrée" dont les fleurs, beaucoup plus grandes, ont une longue corolle tubulaire. Sa floraison est plus tardive. Elle commence au plus tôt au premier septembre, elle se poursuit jusqu'à la fin du mois d'octobre si la saison est favorable. La *Calluna* produit beaucoup de nectar qui, d'après R. M e m e r y, se formerait encore à une température de 11°. Son miel visqueux ne s'écoule pas de lui-même des cellules où il est emmagasiné, il ne peut pas être retiré par centrifugation à l'extracteur, il faut avoir recours à la presse. En opérant proprement on obtient un produit de peu de saveur, utilisé à ce titre pour faire des coupages en vue d'adoucir l'odeur assez forte du miel de Tilleul ou de *E. cinerea*.

Parmi les autres plantes mellifères il faut signaler la Bourdaine ou Nerprun (*Rhamnus frangula* L.), arbuste dont la floraison échelonnée d'avril à septembre fournit un appoint important pour les abeilles tout au cours de la saison. Dans certaines localités les apiculteurs récoltent parfois au printemps du miel de Bourdaine.

L'activité des mouches à miel est en relation étroite avec la flore, mais le temps doit être aussi favorable. Les années à grands vins ont généralement été des époques de famine, la sécheresse arrête la montée du nectar qui semble se développer surtout au cours de journées orageuses et chaudes où l'atmosphère est chargée d'humidité. La nature du sol corrige parfois ces déficiences, la carte floristique, établie par R. M e m e r y, distingue des zones moins arides où les bruyères souffrent peu (Fig. 1).

L'espèce la plus communément répandue est l'Abeille noire (*apis mellifica* L.), on rencontre aussi une forme hybride révélant l'importation d'un assez grand nombre de reines italiennes (*apis ligustica* Sp.).

La ponte débute en février. Le couvain est d'abord nourri avec le pollen récolté sur *Ulex europaeus* L. et sur *Salix cinerea* L. Les abeilles butinent bientôt sur *Rhamnus* mais la grande miellée commence assez tard, au moment de la floraison des Bruyères (Fig. 2). A la mi-juin dans les coins les plus favorisés où abonde *E. cinerea*; fin août partout ailleurs, en particulier dans la lande girondine, où domine *Calluna*. Les dates d'essaimage sont en relation avec les périodes de grande activité. Les essaims de septembre peuvent subsister dans la lande grâce à la petite Bruyère, mais ils ne pourraient

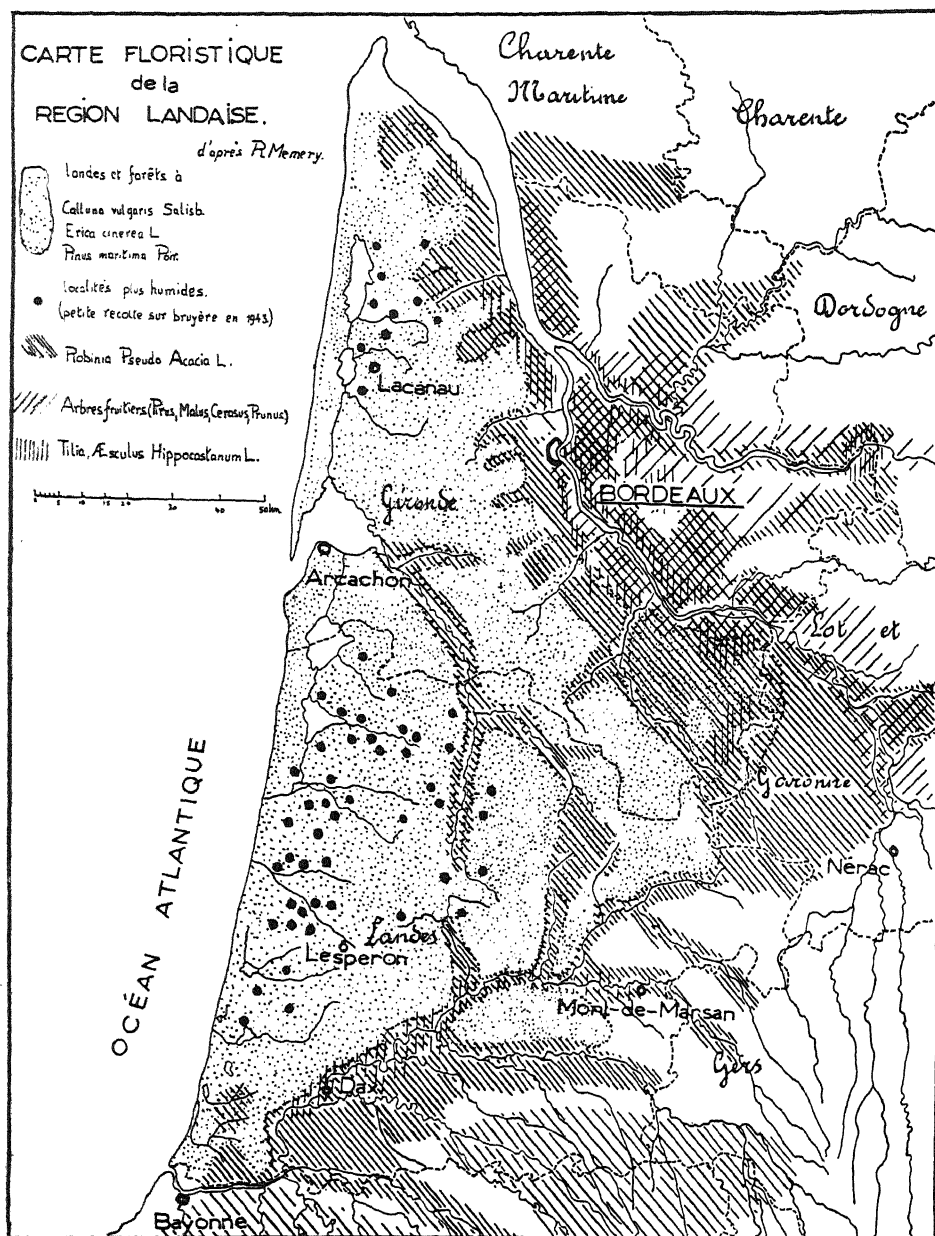
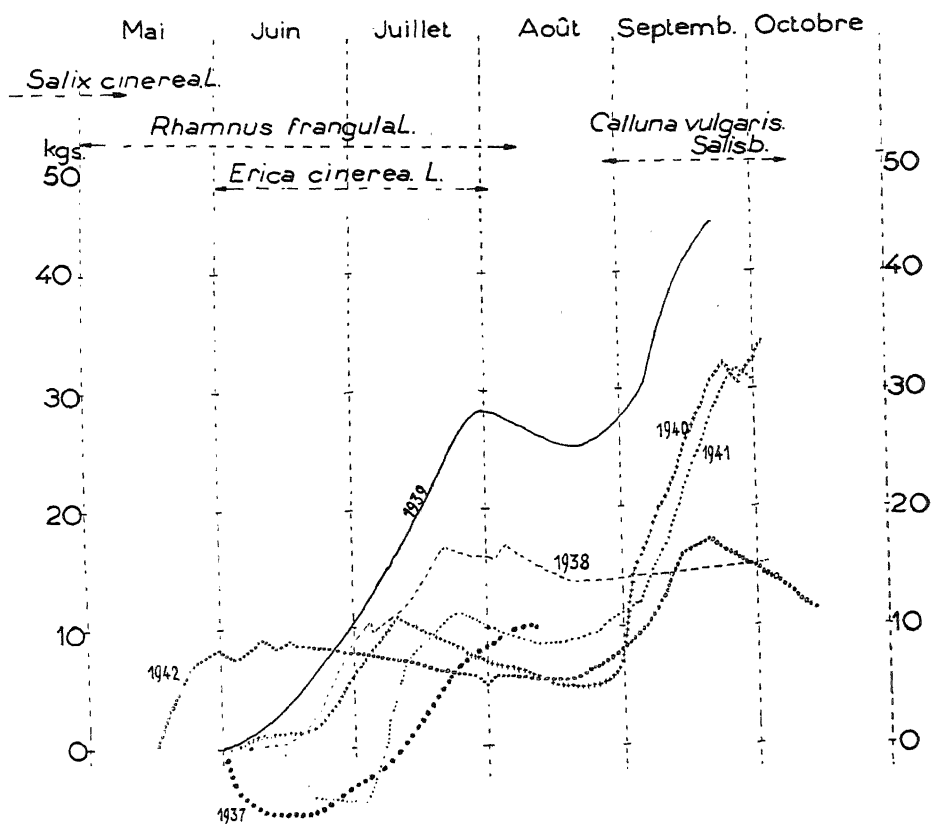


Fig. 1. Carte floristique de la région landaise (établie par R. Memery).

## MIELLÉES TARDIVES de la RÉGION des LANDES.

Lacanau-Médoc (Gironde) Dr. Mathio.



	1937	1938	1939	1940	1941	1942
Ruche sur bascule {	10	14,5	4,4	3,4	31	17
Moyenne des ruches { (120 - 160)	10	0	13,5	9	9,9	8

Fig. 2. Miellées tardives de la région des landes.

pas se constituer des réserves suffisantes pour passer l'hiver dans toutes autres régions. La ponte s'arrête fin octobre et les abeilles entrent en hivernage.

#### *Les divers modes d'exploitation des abeilles —*

Les régions les plus deshéritées, comme la lande girondine, ont conservé les paniers.

La ruche Langstroth standard, à corps et hausses semblables, est très répandue dans la Grande Lande où la miellée longue, abondante et régulière, de la Bruyère cendrée permet d'obtenir de très fortes populations. Le couvain, réparti dans une vingtaine de cadres, s'étage sur plusieurs corps. L'extraction du miel se fait au 15 août et le produit de la Callune est souvent laissé aux abeilles pour l'hivernage.

Certaines localités bien situées à proximité des petites rivières (Vallée du ciron dans le Bazadais, Vallée de la Leyre, etc.) peuvent en outre compter sur une miellée de printemps au moment de la floraison des acacias (*Robinia Pseudo-Acacia* L.). Ces régions ont aussi adopté la ruche à cadres avec laquelle il est possible de faire des récoltes successives sans trop gêner le développement des colonies (Fig. 3).

Quelques professionnels pratiquent l'apiculture pastorale. Les ruches sont d'abord mises en Chalosse ou dans la Vallée de la Garonne : régions précoces où l'acacia et le trèfle incarnat (*Tr. incarnatum* L.) donnent une première récolte. Elles sont ensuite transportées dans la lande au moment de la mise à fleurs des Bruyères qui fournissent une seconde production. On les ramène plus tard à leur emplacement de printemps.

#### *La pratique landaise avec étouffage —*

Les essaims sont logés dans un panier appelé "bournac". Celui-ci est fabriqué l'hiver par le résinier lui-même avec des branches de châtaigniers fendues, tressées puis revêtues d'une épaisse couche de bouse (excrements) de vache qui en assure l'étanchéité. Le tout est protégé des intempéries par un chapeau de fougères simplement posé par-dessus (Fig. 4).

Au nord-ouest de Bordeaux on rencontre surtout un panier en pain de sucre offrant une capacité d'une trentaine de litres (42 cm. de diamètre à la base et 65 cm. de hauteur) (Fig. 7). Plus au sud les apiculteurs préfèrent un type original, plus difficile à construire, mais qui semble être une amélioration du précédent. Le modèle adopté est un peu plus haut, avec un étranglement au tiers supérieur de manière à délimiter au sommet une espèce de sphère où les abeilles se trouvent bien au chaud pendant l'hiver (Fig. 5). En outre ce resserrement offre un soutien pour les rayons, il les maintient bien en place, les empêchant de s'effondrer pendant les grandes chaleurs.

La pratique courante apicole est bien simple. Dès sa capture le nouvel essaim est jeté dans un "bournac" que l'on pose dans le rucher, à même le sol. Les abeilles entrent et sortent par le bas du panier, choisissant le côté le mieux éclairé. Elles construisent des gâteaux de cire pour élever leur couvain et emmagasiner leurs provisions de miel et de pollen. Les rayons s'allongent parallèlement l'un à l'autre (Fig. 6), ils emplissent peu à peu tout l'espace offert sans que l'apiculteur intervienne. L'année suivante, si la miellée est forte, la colonie, se trouvant vite à l'étroit, peut donner successivement plusieurs essaims qui seront recueillis à leur tour.

En fin de saison, au moment de la fête de la Toussaint, lorsque les abeilles n'élèvent presque plus de couvain, le résinier soupèsera ses paniers et sacrifiera les mieux remplis et les plus lourds pour en retirer le miel et la cire. Il fait brûler une mèche de soufre au-dessous de la ruche et l'enveloppe aussitôt d'une toile de sac ou d'une couverture pour éviter la fuite du gaz sulfureux par les interstices (Fig. 7). Les abeilles, vite

## MIELLÉES MULTIPLES des PETITES VALLÉES des LANDES.

Lesperon (Landes) Mr. Granel.

1926: année exceptionnellement bonne.

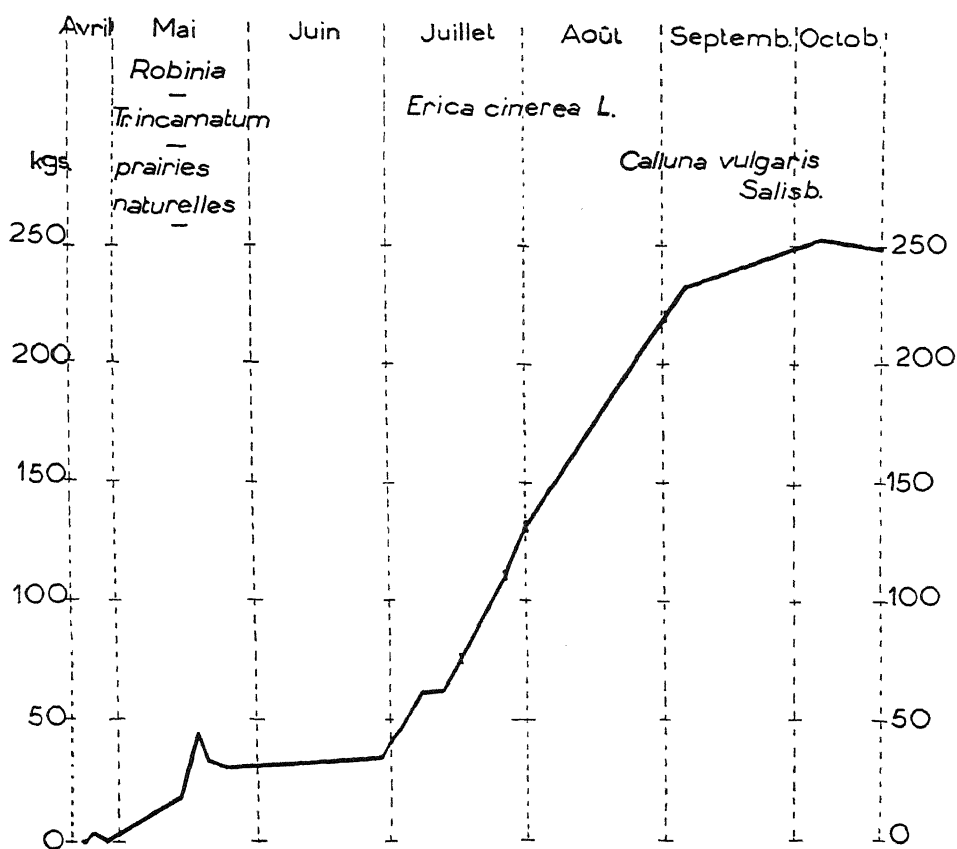


Fig. 3. Miellées multiples des petites vallées des landes.

## L'APICULTURE DE LA REGION LANDAISE (FRANCE SUD-OUEST)

(Ph. Puytorac).



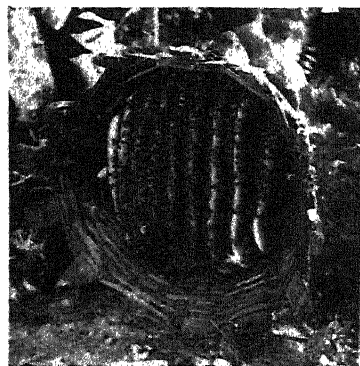
*Panier landais avec étrangement.*  
Fig. 5

*Etoffage d'une ruche.*

*Une couverture évite la fuite du  $SO_2$  (paniers en pain de sucre recouverts de fougères).* Fig. 7



*Mise en place du chapeau de fougères recouvrant le panier landais.* Fig. 4



*Panier renversé montrant les rayons construits par les abeilles.* Fig. 6



*Recolte du miel: les rayons sont entassés dans une barrique.* Fig. 8



asphyxiées, tombent en tas sur le sol ou meurent dans les alvéoles en voulant se gorger de miel. C'est la pratique de l'étouffage, encore trop répandue. Les paniers morts sont transportés à l'écart auprès des barriques vides prêtées à l'avance par l'acheteur habituel. Les gâteaux de miel sont découpés, jetés pêle-mêle dans les fûts, mélangés et écrasés avec les rayons contenant encore un peu de couvain mort, des cadavres d'abeilles ou du pollen (Fig. 8). Les barriques pleines sont fermées et roulées jusqu'au hangar où elles attendront parfois plusieurs mois la venue du ramasseur. Un industriel séparera à la presse le miel et la cire.

La persistance du panier landais, avec sa récolte par étouffage, tient surtout à sa simplicité. La conduite du rucher n'exige *aucune surveillance*, si ce n'est au moment de la capture des essaims, il n'y a *pas non plus de soins particuliers à donner aux abeilles*.

En outre, le miel de la Callune ne peut pas être extrait facilement par centrifugation, cela n'incite guère les apiculteurs à changer leurs habitudes car ils devront toujours recourir à la presse, même avec des ruches à cadres.

Le renouvellement des colonies par essaimage naturel permet de maintenir des populations toujours saines et vigoureuses. L'étouffage élimine rarement des sociétés vieilles ou souffreteuses, il sacrifie surtout des paniers abritant des abeilles vigoureuses à l'étroit dans de vieilles bâtisses pleines de miel. Ces colonies ont déjà donné un ou plusieurs essaims, elles ont une reine jeune, elles seraient susceptibles de bien travailler l'année suivante si elles avaient plus d'espace. Il y aurait donc *grand intérêt à les sauvegarder* et à les récupérer au printemps (par transvasement ou par tapotement) afin d'éviter une sélection à rebours.

Le mode de récolte avec son mélange grossier de vieilles bâtisses et d'abeilles mortes donne un miel de qualité inférieure contenant trop de matières organiques fermentescibles. Les industriels qui l'achètent à bas prix en tirent grand profit car ils travaillent aussi la cire dont la valeur est très élevée.

Enfin, objection importante du point de vue sanitaire, les rayons des paniers sont difficiles à examiner en cas de maladie du couvain.

#### *Conclusions —*

L'apiculture de la région des landes est conditionnée par :

1.— *la flore*, facteur naturel sur lequel il est impossible d'agir. Par suite de sa viscosité le miel de *Calluna vulgaris* devait, jusqu'à présent, être extrait à la presse, cela oblige à démolir les bâtisses qui donneront la *cire, production essentielle*. Les landais ne tirent pas grand profit de leur cire car elle est comprise dans le produit brut dont la mauvaise présentation diminue la valeur marchande.

2.— un *facteur technique humain* dû au mode ancien d'exploitation des abeilles dans des *ruches indéformables* qui activent la formation des *essaims*. Ceux-ci assurent le changement fréquent des colonies du rucher dont l'état sanitaire est généralement très bon. Ils constituent une source réelle de revenu par la vente de paniers peuplés aux apiculteurs utilisant les ruches à cadres, et désireux de produire eux-mêmes leurs essaims. Pour recueillir le miel de ces ruches il faut nécessairement en retirer les abeilles. Elles sont malheureusement détruites par étouffage.

Il est possible et préférable de *conserver les colonies* de valeur jusqu'au printemps pour en tirer parti. L'emploi de modèles rustiques, faciles à conduire et *pouvant se diviser*, permettrait de faire la récolte sans éloigner les abeilles et assurerait le renouvellement des cires sans nuire à la production des essaims.

## MAN'S REACTION TO THE BITES OF CERTAIN ARTHROPODS

By R. M. Gordon and W. Crewe

The object of this address is to record some observations we have recently made on the action of the feeding mechanisms of certain blood-sucking insects, the lesions produced by their bites, and the subsequent reactions exhibited by the mammalian host. We believe that these have an important bearing, in insect-borne diseases, on the acquirement of infection by the insect vector, and later by the mammalian host—indeed this is already well recognised—and that a further study of the reactions in the final host may add to our knowledge of the early stages of development of the parasites causing such diseases.

The course of an insect-borne disease may be influenced by the factors we have just mentioned (the feeding mechanism of the vector, the lesions produced by its bites, and the subsequent reactions of the host) at any one of three natural phases; that is to say, at the time the parasite is taken up by the vector, at the time it is deposited in the new host, and, finally, during its subsequent development.

a) *The taking up of the parasite from the mammalian host.*

Let us first consider the case of the uninfected arthropod feeding on the already parasitised mammalian host. Here, obviously, the nature of its bite may determine the efficacy of the arthropod as a vector. To take two well-known vectors of filariasis as examples; the superficial rasping nature of the bite of flies belonging to the genus *Simulium* clearly allows them to take up many skin-inhabiting microfilariae when feeding on a host infected with *O. volvulus*, while mosquitoes, with their deeply piercing fine mouthparts, are better adapted to taking up the blood-inhabiting larvae of *W. bancrofti*. In the latter instance it has been shown that the number of microfilariae taken up is further influenced by whether the insect obtains its blood directly from a capillary or from a tiny pool of blood caused by previous laceration of a vessel.

b) *The deposition of the parasite in the mammalian host.*

If we next consider the case of the already infected arthropod feeding on the uninfected mammalian host, it is at once clear that the nature of the bite will determine the site and distribution of any introduced parasites, as well as the nature of the medium in which they are deposited. In addition, it is possible that any subsequent reactions of the host to the saliva of the biting insect may further influence the introduction of the parasite and its subsequent development.

We might illustrate some of these points by examples selected from well-known tropical diseases. In the case of malaria it has been shown that the feeding mosquito introduces sporozoites into the tissues, as well as directly into the peripheral circulation. The fate of these is not yet clear; in the case of bird malaria, due to *P. gallinaceum*, we know that some of the sporozoites develop at the site of the bite, while in the case of human malaria it appears probable that only those sporozoites which reach the internal organs undergo further development. In the case of African trypanosomiasis, as in malaria, it is probable that there is a primary phase of development, but our ignorance of the feeding mechanism of *Glossina* prevents us from knowing exactly where the metacyclic trypanosomes are deposited. We do, however, know that some

of them undergo development at the site of inoculation, and our own observations suggest that they are mainly deposited in, or close to, an extravasation of blood.

c) *The subsequent development of the parasite in the mammalian host.*

As regards the effect on the parasite of the subsequent reactions of the mammalian host, we know, of course, that the irritation following the introduction of the insect's saliva into sensitised persons results in scratching, and that in such persons the risk of acquiring typhus from infected lice, or South American trypanosomiasis from infected bugs, is greatly increased. On the other hand, we are almost completely ignorant of the effect on the introduced parasite of any of the other subsequent reactions occurring in the mammalian host. In addition to any haemorrhage caused by the bite of the vector there is, in individuals who have become sensitised by irregular exposure to the bites of the insect concerned, an immediate oedematous reaction characterised by separation of the collagen fibres, dilatation of the capillaries, and leakage of fluid from the capillaries into the surrounding tissues. It is quite possible that such local reactions to the secretions of feeding insects may alter the development of parasites introduced by them if such parasites, either protozoan or metazoan, undergo a primary phase of development at the site of inoculation.

Our own investigations have been concerned mainly with the effects of the bites of mosquitoes, but they have included some observations on those of the tsetse fly and the bed bug.

The literature concerning the bites of these insects is extensive, but the usually accepted views as they appear in most textbooks on medical and veterinary parasitology might be expressed somewhat as follows. The insect cuts the skin, causing the minimum of damage, and through the wound thus made it inserts its proboscis and injects saliva into the tissues of its host. The proboscis is a more or less rigid structure, and the insect inserts it to an increasing depth until it encounters a blood vessel from which it feeds. When it has finished its meal the insect withdraws the proboscis along the same path by which it entered, so that, as a result of this very fine instrument being inserted along a single path, practically no trauma and very little haemorrhage into the tissues is produced. As regards the subsequent reaction, it is generally thought that the bites of these three insects normally produce some reaction, although the intensity of this reaction varies according to the individual's previous history of exposure. Thus some persons become increasingly sensitive to the bites of certain species whilst others develop an immunity and eventually cease to react. In addition to this visible reaction, it is generally accepted that some degree of itching is associated with the bite, the intensity varying proportionately with the visible reaction.

This very generalised picture has been modified by various workers, and as a result of their and our own observations we think that a truer picture would be somewhat as follows:—

1. The proboscis of the feeding insect, in the case of the mosquito, the tsetse, and the bed bug, is a flexible structure with which the insect probes the tissues of its host in all directions, producing a certain amount of laceration, the extent of which, at any rate in the case of the tsetse, is probably greater than was previously realised. In the case of the mosquito, and probably also in the case of the bed bug, feeding sometimes takes place directly from a capillary and sometimes from a haemorrhage caused by the previous laceration of a vessel. In the case of the tsetse the latter method of feeding appears to be the rule.

2. Saliva is introduced into the tissues of the host not only at the commencement of biting, but during the whole act of probing the tissues.

3. The subsequent reactions exhibited by the mammalian host are of two types, a delayed reaction and an immediate reaction.

The relayed reaction, when it occurs, is independent of previous biting and is, therefore, not the result of previous sensitisation. If persons exhibiting a delayed reaction are regularly exposed to bites of the same insect they do not become sensitised and the delayed reaction becomes progressively less intense and of shorter duration. We suggest that the "immunity" to mosquito bites generally exhibited by natives of all ages in the tropics is not a racial characteristic, but is due to the fact that from an early age they are regularly exposed to the bites of these insects.

The immediate reaction is dependent on previous sensitisation and is not observed in persons who have never previously been bitten by the species of insect responsible, nor, as already stated, does it occur in persons regularly and constantly exposed to bites from the same species. On the other hand, a proportion of persons who are irregularly exposed to the bites of one species of insect become sensitised to that species and subsequently exhibit an immediate reaction as distinct from the delayed reaction.

If persons showing an immediate reaction are irregularly exposed to further bites from the same species the sensitivity persists for an indefinite period. If, however, they are regularly bitten at short intervals the duration and intensity of the immediate reaction become progressively, though irregularly, less, the start of the reaction remaining immediate.

Desensitisation as well as sensitisation appears to be highly specific. Thus an individual sensitised to *Aedes*, *Culex*, and *Anopheles*, and subsequently desensitised to *Aedes*, still gives a strong reaction to the bites of the remaining two genera.

In this short space it has not been possible to deal with the details of the experiments which have led us to the conclusions given, and for the same reason we have made little reference to the extensive literature concerning insect bites. We can only state that many, though not all, of the points we have mentioned have already been the subject of communications from previous workers.

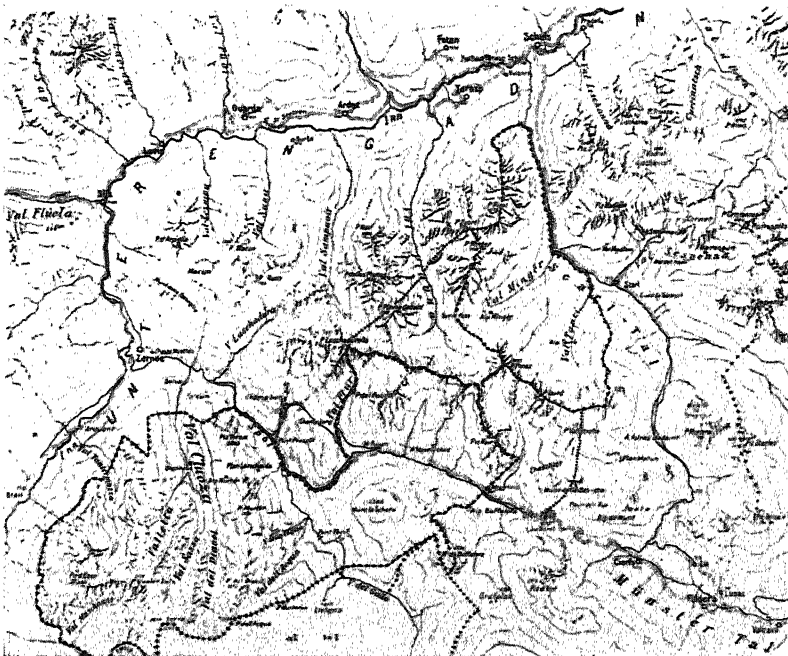
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## DIE ENTOMOLOGISCHEN UNTERSUCHUNGEN IM SCHWEIZERISCHEN NATIONALPARK IM UNTERENGADIN

Von *Eduard Handschin*

Mit der Schaffung des schweizerischen Nationalparks wurde derselbe der wissenschaftlichen Ueberwachung und Kontrolle unterstellt. Seit 1916 werden deshalb ununterbrochen Untersuchungen über die gesamte Natur des Reservates nach einem bestimmten Programm durchgeführt und von einer Kommission der schweizerischen Naturforschenden Gesellschaft geleitet.

Das Arbeitsprogramm war anfänglich denkbar einfach. 260 km<sup>2</sup> vorwiegend einheitlicher alpiner Koniferenwald und etwas Alpweiden wurden vollständig der Ueberwachung durch den Menschen entzogen. Es galt also einmal zu untersuchen, ob die Umgebung durch ein solches Experiment nicht gefährdet wurde. Dann galt es für das Gebiet eine Inventarisierung vorzunehmen und endlich die Veränderungen zu studieren, denen Flora und Fauna durch die völlige Aufgabe der Kultivierung unterworfen war. Es handelte sich also von Anfang an um eine Ganzheitsanalyse der gesamten alpinen Stufe im Bereiche der engadiner Dolomiten. Innere und äussere Schwierigkeiten liessen das Werk nicht so stark fortschreiten, wie es wünschenswert gewesen wäre. Doch liegen heute bereits 18 Monographien vor, vom denen 9 das Gebiet der Entomologie, 3 die Invertebraten und 6 die Botanik betreffen. Eine geologische Aufnahme wurde publiziert und ca. 12 weitere entomologische Arbeiten stehen vor dem Abschluss und werden demnächst erscheinen können.



*Das Gebiet des Schweizerischen Nationalparks.*

Die engadiner Dolomiten, in deren Gebiet der Nationalpark liegt, verdienen nun entomologisch und zoologisch im allgemeinen unsere grösste Aufmerksamkeit. Einmal bilden sie die Grenze zwischen Ost- und Zentralalpen und ihre Wasser fliessen sowohl zur Donau als zur Adria und öffnen so im Alpengebiet die Pforten einer mediterranen wie pontischen Einwanderung. Höhenlage, Bodenbeschaffenheit und Klima bedingen aber naturgemäss die gegebene stufenweise Verteilung der Formen. Von der Umgebung von Schuls (bei ca. 800 m) bis Scafs (1600 m) der Sohle des Inntals erhebt sich der Park bis in die Schneeregion (3200 m). Er wird eingehüllt von einem ca. 2–6 km breiten einheitlichen Gürtel von Coniferen, der nur in den tiefern Lagen (Zerne, Schuls) und an ganz wenigen Enclaven von vereinzelt Laubbaumbeständen durchbrochen wird. Dadurch entsteht eine gewisse Einförmigkeit in der Zusammensetzung der gesamten Insektenwelt. Die meisten, auf Laubbäume angewiesenen Arten fehlen ihm vollständig.

Dieser Wall von Coniferen kann nur an einigen Stellen und von wenigen Formen überwunden werden. Längs den Flüssen und Strassen entwickeln sich Stellen, die einer Wanderung günstig sind. Doch werden in der Regel dieselben nur von wenigen Arten benützt, wenn Verbindungen mit offenem Gelände die Tiere anzulocken vermögen. Auch die Exposition der Täler ist von Bedeutung. Ost—West gerichtete Talschaften mit Nord—Südexposition der Talflanken schaffen maximale Gegensätze. An S. exponierten Talflanken entwickeln sich xerotherme Stellen und rufen einer xerophilen Tierwelt, d. h. in alpinen Gegenden mit extremen Klimaschwankungen, wo eigentlich die ganze Tierwelt xerophil wird, führen sie zur Besiedelung des Gebietes. Nord—Süd Täler verhalten sich je nachdem die Talöffnung im S. oder N. liegt verschieden. Sie tragen im allgemeinen den Charakter der event. W.—O. gerichteten Talsohle oder deren Mündungsstelle.

So zeigt z. B. das Inntal eine ausserordentlich reiche Fauna, die von Schuls nach W. aber rasch verarmt. Reich sind die linken Talseiten des Inns, arm die rechte Talseite. Dies gilt auch für die entsprechenden Nebentäler. Im Ofengebiet wird durch die dichte Bewaldung und durch den doppelten Felsriegel bei il Fuorn und Süsom-Givé die Fauna des Haupttales ausgeschlossen, ebenso kann diejenige des Münstertales von Süden her nur bis il Fuorn vordringen oder sie gelangt über den Scarlpass bis nach Scarl, wo sie von den Felsriegeln des Piz Madlein und Pisoc aufgehalten wird. Der Scorpion (*Euscorpis italicus*) macht im Münstertal vor der Passhöhe bei Champatch halt (2000 m). *Acmaeops pratensis* zieht über den Pass hinüber bis nach il Fuorn und Scarl. Dem Inntal fehlt die Art. Dafür findet sich dort bei Zerne und Schuls *Judolia erratica* und *Leptura sexmaculata* um zwei Beispiele zu nennen die noch nicht durch die Schluchten der Clemgia und des Spöls nach oben gestiegen sind.

Im Gebiete des Parkes zeichnen sich, wie überall in den Alpen die Klimagrenzen stark ab. Mit je 250 m Erhebung senkt sich die Durchschnitttemperatur um ca. 1,5° ab, was bedingt, dass zeitlich das Schwinden des Schnees und das Beginnen der Blütezeit der Pflanzen zeitlich auf engem Gebiete sich stark verschieben. So kommt es, dass auch die Erscheinungsdaten der Schmetterlinge sich stark verschieben und den Wärme-Entwicklungsgesetzen folgend, sich stark verlängern. Bei einer Tour auf die Fuorcla Val dal Botch kann man auf der kleinen Alp bei ca. 2000 m *Zygaena exulans* in vollem Fluge antreffen. Kontrollen von 100 zu 100 m Höhe von der Alp zur Passhöhe (2500 m) führen uns zunächst zu Puppen in verschiedenem Grade der Reife, dann zu alten Raupen und endlich in der Höhe zu jungen Larven, mit andern Worten also von Tieren einer univoltinen Rasse zu einer solchen von 2 jähriger Entwicklung.

Durch dieses zeitlich verschiedene Auftreten der Art haben sich also eigentlich 2 biologisch verschiedene Rassen herausgebildet, deren Flugzeiten innerhalb eines Gebietes von ca. 1 km Länge so weit auseinander liegen, dass Kreuzungen derselben praktisch ausgeschlossen sind. Die Form fliegt allgemein so lokal, dass auch an warmen Tagen bei reichem Fluge in der Tiefe, sich keine Tiere in die Höhe verirren. Es wäre höchstens denkbar, dass in mittlern Lagen Spätflieger der univoltinen Rasse mit Frühfliegern der 2 jährigen Form zusammentreffen könnten. P i c t e t hat versucht, die entsprechenden Verhältnisse für eine ganze Anzahl von Arten zu analysieren. Er kommt zur Annahme eigentlicher, auch morphologisch differenzierter Rassen, die dem Parkgebiete eigen sind und die als Mischformen die Populationen der Täler und Hochalpen, wie auch die nördlichen und südlichen Alpengebiete verbinden. Ganz ähnliche Verhältnisse zeichnen sich bei den Coleopteren und Dipteren ab. Dort sind es allerdings mehr die speziellen Verbreitungstendenzen der Formen, die ökologisch sich stark gegeneinander abheben und die den Vorstoss vom Tal zur Höhe und umgekehrt bei den eigentlichen Hochgebirgstieren kenntzeichnen. Fast in jeder Gattung finden Arten, die rein hochalpin, die Tendenz zum Vordringen in die Tiefe besitzen, wie auch andererseits Talformen ihr Verbreitungsgebiet gegen die Höhe zu erweitern.

Dies zeigt sich nun besonders in der Verfolgung der Verteilung der Formen im Laufe der Jahreszeiten, wie auch im Verlaufe des Geschehens eines Tages. Für alle solche phaenomenologischen Probleme ist natürlich Voraussetzung, dass der Ablauf des Tagesgeschehens bekannt ist, ebenso wie es für die Beurteilung des Faunenbildes wichtig ist, das Milieu ökologisch zu erfassen. K e i s e r hat bei der Bearbeitung der Fliegen versucht, eine möglichst genaue Analyse der Zusammensetzung der Population während des Ablaufs des Tages zu geben. Er zeigt damit, wie ausserordentlich wichtige Faktoren durch Strahlung und Temperatur gegeben werden und wie im Laufe des Tages die kleinste Aenderung im Lokalklima das Faunenbild zu beeinflussen vermag. Da nun die temporären Veränderungen, die Sukzessionen der Pflanzen und Tierverbände zum Hauptziel der Studien im Parke gehören, werden bestimmt ausgewählte Lokalitäten speziell auf solche Faktoren dauernd untersucht, an solchen Stellen geht vor allem die Ganzheitsanalyse vor sich. Nach einer von P a l l m a n n ausgearbeiteten Methode wird für jede Station an typischen Stellen im Boden, auf demselben und ca. 1 m in der Luft eine Wärmesummenmessung vorgenommen. So erhält man einen Einblick in das thermische Geschehen von den höchsten Gipfeln zur Talsohle und zwar je in 50m Höhenunterschied in ununterbrochenen Profil. An den Untersuchungsstellen im Tale wird der Boden sowohl chemisch als physikalisch untersucht, auf seinen Bacteriengehalt, die Bodenalgae und die Bodenfauna geprüft, wobei der Celluloseverdauung der Waldstreu besonderes Augenmerk zuteil wird. Die dadurch wechselnden Bedingungen im pH-Gehalt bedingen auf kleinstem Raume schon bedeutende, charakteristische Veränderungen in der Pflanzendecke und damit in der Tierzusammensetzung. Von dem an zentraler Stelle in il Fuorn 1946 errichteten Laboratorium werden an typischen Wald- und Wiesenassoziationen diese Untersuchungen verfolgt.

In wieweit die mit dem hohen Nitratgehalt des Wiesenbodens in Zusammenhang stehende Bildung der Lägerformation auch mit dem Bacteriengehalt in Verbindung steht, bleibt zu ergründen. Tatsache ist, dass mit der Auslaugung des Bodens an einzelnen Stellen die Läger ganz verschwunden sind, wobei gleichzeitig eine Verminderung des Bacteriengehaltes des Bodens von  $70 \cdot 10^6$  auf  $2 \cdot 10^6$ /per CC konstatiert wurde. Mit der Lägerflora verschwanden aber die typischen Insekten, auf la Schera

z. B. die seltene *Coccinella trifasciata*, die dort in einer grossen Kolonie vorhanden war.

Auch der moderne Autoverkehr längs der Ofenstrasse hat seinen störenden Einfluss auf die Entwicklung der Insektenwelt. Die starke Staubentwicklung längs der Strassenränder hat ihren Einfluss auf die Nektarbildung und Pollination der Pflanzen. Staubbedeckte Pflanzenteile eignen sich schlecht als Nahrung für die Larven. Zahlreiche Schmetterlinge, die sonst den Wanderstrassen folgen, — Melitaeen, Erebiën, Lycaeniden und Zygaeniden sind seltener geworden. Allerdings war während der Jahre 1939—1945 der Verkehr stark eingeschränkt worden. Die entsprechenden Formen zeigten sofort eine starke Zunahme. Wir müssen hier aber auch an die Möglichkeit einer rhythmischen Fluktuation des Individuenbestandes denken, die sich von Zeit zu Zeit wiederholt. Doch ist es auffallend, dass eine solche Zunahme sich sofort wiederum geltend machte, als die starke Staubentwicklung längs der Strasse unterbunden war.

Der Weidegang auf den Alpen des Parkes hat aufgehört. Mit ihm sind eine ganze Anzahl coprophager Insekten verschwunden. 1916 ist aber der Hirsch ins Gebiet des Parkes eingewandert und hat auf den Weiden begonnen, das Vieh zu ersetzen. Seit seiner Ankunft und grossen Vermehrung wird der sich verfilzende Rasen wieder kurz gefressen und gedüngt. Eine Anzahl Aphodiusarten sind mit ihm neu ins Gebiet eingedrungen und die gewöhnlichen alpinen Arten, die sonst nur im Gems- und Gämsskott wenig zahlreich gefunden wurden, haben sich beträchtlich vermehrt (*Aphodius putridus*, *mixtus* etc.). Auch die vorher kaum bekannte Rachenbremse des Hirschwildes tritt heute häufig auf. Wie sich die Verteilung und Verbreitung der alpinen Pflanzen durch das Eingreifen des Wildes gestalten wird, ist vorderhand noch nicht zu sagen. Doch lassen Untersuchungen von Müller über die endozoochore Samenverbreitung durch das Wild in dieser Hinsicht grosse Veränderungen erwarten.

Wenn so heute besonders biologisch-ökologische Probleme der hochalpinen Fauna im Parke zur Bearbeitung gelangt sind, so stellt doch die bis jetzt geleistete Arbeit in erster Linie den Grundstock einer Gesamtanalyse der Fauna dar, welche auch das umliegende Gebiet des Inn- und Isartales und das südliche Münstertal umfasst. Dadurch erhält die Arbeit grösste Bedeutung im Rahmen der zoologischen Erforschung der Alpen im allgemeinen. In der Frage nach der Herkunft der einzelnen Faunenkomponenten spielen die weniger beweglichen Arten nun immer eine grosse Rolle, und unter ihnen sind es die alpinen Endemismen und boreoalpinen Arten welche an erster Stelle stehen. Als Beispiel mögen hier die Verhältnisse, wie sie bei der Analyse der Collembolenfauna gewonnen worden sind, angeführt werden. Hier finden wir z. B. das Maximum der Endemismen in der hochalpin-nivalen Stufe, während die als Glacialrelikte angesehenen boreo-alpinen Formen sich im Gebiet der oberen Waldgrenze und in der obersten Weidenzone anhäufen. Wenn wir die heutige starke Gebundenheit der Arten an die einzelnen Biotope voraussetzen, so würde dies heissen, dass diese gemeinsamen Elemente mit dem Norden nur unter der Voraussetzung ihr ehemals gemeinsames Verbreitungsgebiet besiedelt hätten, wenn der eisfreie Streifen beiden eben das gemeinsame Lebensgebiet geboten hätte, d. h. wenn zwischen Nordland- und Alpenis sich ein zusammenhängender Coniferen- und Wiesengürtel gefunden hätte. Erst durch das Eindringen der Laubwälder ist eine biologische Trennung der beiden Regionen entstanden.

Neben den grossen Trennungslinien der Faunen spielt aber auch die räumliche Sonderung auf kleinem Gebiet eine grosse Rolle. *Nebria germari*, die im Parke häufig ist, geht westlich bis zur Albula. Darüber hinaus ist sie noch nicht gefunden worden. Andererseits scheint *Nebria austriaca* im Parke die Westgrenze ihres Vordringens zu finden. Ähnliches zeigt Pictet für die Schmetterlinge, Bigler für die Diplo-



poden, Keiser für die Fliegen, Thomann für die Microlepidopteren und Schweizer für die Landmilben.

Aus dem ganzen Arbeitsgebiet, das nun seit 30 Jahren ununterbrochen bearbeitet wird, war es mir vergönnt, Ihnen einige der wichtigsten Probleme vorzulegen. Die Arbeiten werden weitergeführt. Wenn auch in unsern „Mitteilungen“ noch nicht alle Resultate veröffentlicht worden sind, so glaube ich doch sagen zu dürfen, dass der Nationalpark im Unterengadin mit unserer Arbeit zu einem der best erforschten Gebiete der Schweiz und der Alpen geworden ist.

#### LITERATUR

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## DIE OLIGOPHAGIE PHYTOPHAGER INSEKTEN ALS HINWEIS AUF EINE VERWANDTSCHAFT DER ROSACEAE MIT DEN FAMILIEN DER AMENTIFERAE

Von *Erich Martin Hering*

Unter den Lebensäusserungen der phytophagen Insekten ist besonders fesselnd und richtunggebend nicht nur für den Entomologen, sondern gleicherweise auch für den Botaniker der *Phagismus*, die Nahrungsauswahl der Larven so vieler Arten. In manchen Fällen fressen sie wahllos oder fast wahllos jede grüne Pflanze, in anderen beschränken sie sich auf eine bestimmte Pflanzenart und verhungern eher, als dass sie eine andere annehmen, wenn ihnen die bei ihnen festgelegte nicht geboten wird. Wir sprechen im ersten Falle von *Polyphagie*, im letzten von *Monophagie*. Zwischen den monophagen und den polyphagen Arten stehen diejenigen, die mehrere Pflanzenarten für ihre Ernährung verwenden können und sich dabei normal entwickeln; diese Erscheinung bezeichnet man als *Oligophagie*. Diese oligophagen Arten sind von ganz besonderem Interesse; es zeigt sich, dass die von ihnen ausgewählten Nährpflanzen meistens in gewisser verwandtschaftlicher Beziehung stehen, und die Pflanzenverwandtschaft, auf die solche Arten hinweisen, ist in den meisten Fällen von der Botanik bereits nachgewiesen worden; doch gibt es Fälle, in denen noch keine Beziehung zwischen ihnen von botanischer Seite erkannt wurde. Hier ergeben sich Hinweise auf eine Verwandtschaft, die es verdienen, dass ihnen die Botanik nachgeht und sie vielleicht mit botanischen Arbeitsmethoden später einmal nachweisen wird. Getrübt wird das Bild dieser Erscheinungen aber durch das Auftreten einer besonderen Form der Oligophagie, die man als die *disjunctive* bezeichnet: eine Insektenart ernährt sich gleich häufig von 2 oder mehreren Pflanzenarten, die auf keinen Fall phyto-systematisch etwas miteinander zu tun haben. Es wird sich bei Untersuchungen auf diesem Gebiete also um das Problem handeln, ob eine als disjunctiv erkannte Oligophagie etwa auf eine doch vorhandene, bisher nur noch nicht botanisch nachgewiesene Pflanzenverwandtschaft hinweist. Ein besonders auffälliges Problem in dieser Hinsicht stellen die so sehr zahlreichen Arten dar, die gleichzeitig an der Pflanzenfamilie der Rosaceae und an einer der Familien der „Kätzchenträger“, früher als Amentiferae oder Juliflorae zusammengefasst, leben; zwischen beiden Familiengruppen bestehen und bestanden in der botanischen Verwandtschaftsforschung niemals Vermutungen auf eine Verwandtschaft, wenn auch die Stellung dieser Amentiferae im System oftmals gewechselt hat, worauf hier nicht näher eingegangen werden kann.

Um die verschiedenen Arten des Phagismus zu erläutern, soll hier eine Gruppierung desselben gegeben werden, modifiziert nach G. Voigt (1932) und M. Gieysztor (1938), wobei wir zur Kennzeichnung jedesmal ein Beispiel geben wollen, das wir den endophagen Insekten, besonders den Blattminierern, entnehmen, Arten also, die nicht in der Lage sind, etwa aus äusseren Gründen im Verlaufe eines individuellen Larvenlebens (Zwang, Futternot) die Nahrungspflanze zu wechseln. Wir unterscheiden danach die folgenden Arten der Nahrungsauswahl:

A. *Euphagie*. Die Larven ernähren sich von ihrer normalen Futterpflanze.

I. *Monophagie*. Monophage Arten fressen nur von einer einzigen Pflanzengattung oder -Art.

- a. Monophagie 1. Grades. Die Larve lebt nur an einer einzigen Art einer Pflanzengattung. (*Phytomyza pauli-löwi* Hend. frisst nur an *Peucedanum oreoselinum* (L.) Mnch., *Ph. thysselinivora* Hering nur an *P. palustre* (L.) Mnch. (Dipt.))
  - b. Monophagie 2. Grades. Die Larve ernährt sich nur von einigen Arten einer Gattungsgruppe (Sectio) einer Pflanzengattung. (*Phytomyza abdominalis* Zett. (Dipt.) und *Pseudodineura mentiens* Thoms. (Hym.) leben ausschließlich an Anemone-Arten der Sectio Hepatica (*A. hepatica* L. und *A. transsilvanica* (Fuss) Heuff.), *Phyt. pulsatillae* Her. und *Pseudodineura parvula* Klg. nur an Arten der Sectio Pulsatilla).
  - c. Monophagie 3. Grades. Hierher gehörende Larven fressen von allen Arten einer Pflanzengattung. (*Agromyza nigrescens* Hend. (Dipt.) und *Fenella voighti* Hering (Hym.) können an allen Geranium-Arten vorkommen.)
- II. Oligophagie. Oligophage Arten ernähren sich von Pflanzen verschiedener Gattungen.
1. Systematische Oligophagie: Die Nährpflanzen sind miteinander verwandt.
    - a. Oligophagie 1. Grades. Phytophage Insektenlarven, die sich von mehreren Gattungen einer Pflanzenfamilie ernähren. (*Dizygomyza lamii* Kltb. und *D. labiatarum* Hend. leben an fast allen Gattungen der Familie Labiatae, *Philophylla heraclei* L. an fast allen Umbelliferae (Dipt.).)
    - b. Oligophagie 2. Grades. Die Larven leben an verschiedenen Pflanzengattungen, die verschiedenen, näher verwandten Pflanzenfamilien (der gleichen Reihe oder Ordnung) angehören. (*Ceutorrhynchus contractus* Mrsh. (Col.) und *Scaptomyza flava* Fall. (Dipt.) leben an Cruciferae, Resedaceae und Capparidaceae (Reihe Rhoeadales).
    - c. Obligophagie 3. Grades. Die Larven leben an Gattungen von Familien, die verschiedenen Reihen oder Ordnungen angehören, die aber noch näher verwandt sind. (Die Gattung *Elachista* (Lep.) lebt an und nur an Arten der Fam. Gramineae und Cyperaceae (Reihe: Glumiflorae) und Juncaceae (Reihe: Liliiflorae), *Chylizosoma vittatum* Mg. (Dipt.) an Liliaceae und Orchidaceae (Reihe: Liliiflorae und Microspermae).)
  2. Disjunctive Oligophagie: Larve lebt häufig an und nur an wenigen Pflanzen, die nicht miteinander näher verwandt sind. (*Liriomyza eupatoriae* Kltb. an Galeopsis (Labiatae) und Eupatorium (Compositae) (Dipt.), *Lyonetia ledi* Wck. (Lep.) an Ledum (Ericaceae) und Myrica (Myricaceae).)
- III. Polyphagie. Ernährung der Larve durch viele, nicht näher miteinander verwandte Pflanzengattungen.
- a. Polyphagie 1. Grades. Ernährung der Larve fast wahllos durch verschiedene Gattungen einer Pflanzenklasse. (*Cnephasia chrysanthæana* Dp. und *C. virgaureana* Tr. an den verschiedensten Dicotyledonen. (Lep.).)
  - b. Polyphagie 2. Grades. Vorkommen an Pflanzen verschiedener Klassen (*Cnephasiella incertana* Tr. (Lep.) an Dicotyledonen und Monocotyledonen.)
- IV. Pantophagie. Larve kann sich von fast allen Blattgrün führenden Pflanzen ernähren (*Lycoria*-Arten (Dipt.) an Phanerogamen und Cryptogamen).
- B. Xenophagie. Das gelegentliche Vorkommen einer Art an einer nicht verwandten Pflanze (Verlegenheits-, Not- oder Zufalls-Substrat). (*Lithocolletis ulmifoliella* Hbn. Lep.), normal an Betula, an einem von einer Betula durchwachsenen Ribes-Strauch, *Pegomyia bicolor* Wied. (Dipt.) von Polygonaceae an Begonia.

Dass eine systematische Oligophagie phytophager Insektenlarven auf eine Verwandtschaft der befallenen Pflanzen hinweist, dafür gibt es zahlreiche Beispiele, namentlich unter den endophagen Insekten. Es erübrigt sich, solche Fälle für die Oligophagie 1. Grades noch weiter anzuführen. Aber auch für die interessantere des 2. und 3. Grades gibt es namentlich bei endophagen Arten Beispiele genug. Vielfach wurden solche Verwandtschaften von der Botanik erst spät erkannt und teilweise erst durch die Serodagnostik nachgewiesen. Das bei Massenbefall nicht seltene Übergehen der sonst

auf die Oleaceae beschränkten *Gracilaria syringella* Fbr. (Lep.) auf die Caprifoliaceae (Symphoricarpus) ist besonders bemerkenswert, da auch serodiagnostisch eine Verwandtschaft dieser beiden Pflanzenfamilien nicht nachgewiesen werden konnte, unzweifelhaft aber besteht. Die auf die Solanaceae beschränkte *Liriomyza solani* Macq. (Dipt.) tritt namentlich in Gärten auch häufig auf kultivierten Gentiana-Arten auf; die Verwandtschaft der Solanaceae mit den Gentianaceae, die im botanischen System in verschiedenen Reihen (Ordnungen) stehen und auch im serodiagnostischen Stammbaum nicht so benachbart sind, darf darum angenommen werden. *Gracilaria phasianipennella* Hb. (Lep.) lebt normal auf Rumex und Polygonum (Reihe: Polygonales) und Chenopodium (Reihe: Centrospermae), ist aber auch häufig auf Lysimachia (Fam. Primulaceae). Die nahe Verwandtschaft der Primulaceae zu den Polygonales und Centrospermae ist zwar auch serodiagnostisch nachgewiesen worden; aber auch von Wettstein gelangte auf Grund morphologischer Untersuchungen zu einer solchen Beziehung. Dagegen muss das gelegentliche und seltene Vorkommen der Art auf Lythrum (Fam. Lythraceae (sq. Buhr) als ein Fall von Xenophagie gewertet werden. Die Artengruppe der *Phytomyza albiceps* Mg. (Dipt.) hat sich auf die Compositae und Umbelliferae spezialisiert, zwischen denen verwandtschaftliche Beziehungen früher als ausgeschlossen gelten konnten, bis Blass (1930) ihre Verwandtschaft serodiagnostisch nachwies. Bemerkenswert ist dieser Nachweis deshalb, weil er von einem Schüler der Schürhoffschen Schule geführt wurde, deren Tendenz darauf zielte, die Sero-diagnostik als für die Pflanzenverwandtschaftsforschung ungeeignet zu erweisen! Die wenigen hier angeführten Fälle, die sich sehr leicht beliebig vermehren lassen, zeigen, dass die Oligophagie 3. Grades wohl geeignet erscheint, Pflanzenverwandtschaften nachzuweisen, die mit anderen Untersuchungsmethoden nicht herausgestellt werden können. Sie geben uns die Berechtigung zu den folgenden Ausführungen.

Es zeigt sich nun, dass es eine grosse Anzahl phytophager Insektenarten gibt, die auf und nur auf Rosaceae einerseits und auf einer Pflanzenfamilie der Amentiferae andererseits vorkommen, alle übrigen Pflanzenfamilien dagegen meiden. Zu den Amentiferae sollen hier die Salicaceae, Myricaceae, Juglandaceae, Corylaceae und Fagaceae gerechnet werden, deren nahe Verwandtschaft unter sich wohl keiner weiteren Erläuterung bedarf. Beziehungen ergeben sich auch zu den mit ihnen nahe verwandten Ulmaceae, und selbst die Tiliaceae, die in jedem, auch im serodiagnostisch gewonnenen System etwas abseits stehen, lassen noch eine gewisse Verwandtschaft vermuten. Diese gesamte Familiengruppe sei unter den alten Bezeichnung der Amentiferae nachfolgend zusammengefasst. Kein Botaniker wird bereit sein, eine Verwandtschaft der Amentiferae mit den Rosaceae zuzugeben, so labil die Stellung der ersten im Pflanzensystem zu allen Zeiten auch gewesen sein mag.

Es ist belanglos, in den folgenden Zeilen eine Unterscheidung von spezifischer Oligophagie (die gleiche, identische Insektenart lebt an beiden Pflanzengruppen) und generischer Oligophagie (alle oder die Mehrzahl der Arten einer Insektengattung sind auf die beiden Pflanzengruppen angewiesen) vorzunehmen, wenn natürlich auch die spezifische Oligophagie überzeugender wirken mag. Andererseits sind auch hier wieder die endophagen Insektenlarven, die nicht im Laufe des individuellen Lebens unter dem Zwang gewisser Umstände die Nahrungspflanze wechseln können, die für die Beweisführung wichtigeren. Es darf aber nicht unerwähnt bleiben, dass die Larve zu ihrem Aufbau im wesentlichen das Eiweiss der Futterpflanze verwendet, dass Kohlehydrate und auch Chlorophyllkörper von ihrem Körper so gut wie nicht resorbiert werden. Und gerade in den Eiweissen zeigt sich die wirkliche Verwandtschaft der

Pflanzen; namentlich wird ja das nukleäre Eiweiss vorwiegend als der Träger der Vererbung angesehen. Viele serodiagnostische Untersuchungen krankten ja daran, dass für sie das in den Samen vorhandene Reserve-Eiweiss anstatt des Blatteiweisses verwendet wurde. Man weiss, dass die serodiagnostische Reichweite des Reserve-Eiweiss viel grösser und nicht so eindeutig ist wie die des Blatteiweisses. Diese Klippe umgehen also die an oligophagen Insektenlarven geführten Untersuchungen. Belanglos für uns ist auch die Tatsache, dass das Problem eigentlich von der phytophagen Insektenlarve auf die eiablegende Imago verschoben wird, die die Nahrungsauswahl vornimmt. Wesentlich für unsere Betrachtungen ist aber, dass nur Fälle ausgewählt werden, bei denen die gleichen Insekten an beiden Pflanzengruppen, aber nur an diesen beiden, vorkommen und alle anderen Pflanzenfamilien unberücksichtigt lassen.

Identische Arten, die in und nur in den Blättern beider Pflanzengruppen leben, sind *Lyonetia clerkella* L., *L. prunifoliella* Hb., *Leucoptera scitella* Z., *Recurvaria nanella* Hbn., unsere *Tischeria*-Arten (paläarktische Lep.), *Coptodisca splendoriferella* Cl. (Lep.) und *Baliosus ruber* Web. (Col.) in der Nearktis, alle *Rhamphus*-Arten (Col.). Hinzu kommen einander sehr nahestehende, kaum zu unterscheidende Arten wie *Lithocolletis corylifoliella* Hb. (Rosaceae) und *L. betulae* Z. (Betula); *Coleophora serratella* L. (Rosaceae) und *C. fuscedinella* Z. (Betulaceae), die auf beide Gruppen beschränkte Gruppe der *Coleophora palliatella* Zk. (Lep.). Die Fenusiinae (Hym.) sind auf Rosaceae und Amentiferae beschränkt, und nur einzelne Vertreter kommen auch an Ulmaceae, Aceraceae und Tiliaceae vor. Ebenso liegen die Verhältnisse in der Nearktis. *Trachys minuta* L. (Col.) und *Atemelia torquatella* Z. (Lep.) leben an Amentiferae, die erstgenannte auch an Rosaceae, Ulmus und Tilia, letztere auch an Ulmus. *Argyroplote profundana* Fbr. frisst an Quercus (ausnahmweise auch an Prunus padus L.); die ihr äusserst nahestehende, erst kürzlich von ihr abgetrennte *Arg. pomedaxana* Pierce lebt an Prunus padus L. Die *Swammerdamia*-Arten sind auf die Rosaceae und Betula beschränkt, eine Art auch an Empetrum. *Rhagades pruni* Schiff. lebt an Quercus und Prunus, *Carpocapsa pomonella* L. an Rosaceae und Juglans. *Ancylis tineana* Hb., *Pamene spiniana* Dup., *Simaethis pariana* Cl., *Tmetocera ocellana* Fbr., *Cochlidion limacodes* Hufn., *Heterogenea asella* Schiff. fressen an und nur an Amentiferae und Rosaceae. Viele *Acalla*-Arten, *Epiblema*, *Notocelia* wie auch *Nola togatalis* Hb. kommen nur an Amentiferae und Rosaceae vor, so auch *Trachonitis cristella* Hb.

Ähnlich wie bei diesen genannten Lepidopteren liegen die Verhältnisse bei Hymenopteren, den Tenthredinidae. An und nur an Rosaceae und Amentiferae fressen *Rhodogaster punctulata* Klg., die *Dineura*, *Cimbex*, *Trichiosoma*, *Pamphilus*, *Janus*; die *Arge* leben ausserden noch an Berberis, vergleichbar der Lepidopterengattung *Parornix*, die ausser an den genannten beiden Pflanzengruppen in einer Art an Acer vorkommt. Von Tenthredinidae sind auf beide Pflanzengruppen beschränkt die *Allantus*, *Caliroa* (eine Art auch an Tilia), und so werden sich bei genauer Durchsicht phytophager Insektenlarven viele weitere Beispiele finden lassen.

Freilebende Larven können durch äussere Umstände leichter veranlasst werden, ihre Futterpflanze zu wechseln; die unter künstlichem Zwang oft erfolgende Zucht der Macrolepidopteren macht diese zu einem wenig geeigneten Objekt für unsere Betrachtungen. Indessen sollen wenigstens eine Anzahl genannt werden, bei denen das Vorkommen auf beiden Pflanzengruppen auch in freier Natur gesichert ist: *Vanessa polychloros* L. (auch an Ulmus), Gattung *Zephyrus*; die *Drepanidae*, auf Amentiferae beschränkt, die Gattung *Cilix* aber auf Rosaceae; *Saturnia spini* Schiff., *Trichiura crataegi* L., die *Eriogaster*-Arten, *Moma ludifica* L., die *Brachionychia* und *Dichonia*-Arten,

manche *Taeniocampa*, *Mesogona acetosella* F., Gattung *Catocala*, die *Cymatophoridae* (*Habrosyne* und *Thyatira* an *Rubus*!), *Bapta*, *Himera pennaria* L., *Biston pomonarius* Hb. und viele andere.

Zahlreiche weitere Beispiele könnten beigebracht werden, die hier aber nur ermüden würden. Die Häufigkeit dieser Fälle ist so ins Auge springend, dass nicht zu bezweifeln ist, dass ein Pflanzenverwandschafts-Problem vorliegt. Freilich wird der Einwand erhoben werden, dass die Nahrungsauswahl darauf beruht, dass gewisse chemische Stoffe in beiden Gruppen von Pflanzenfamilien vorliegen, die die Bevorzugung durch die phytophagen Insektenlarven veranlassen. Dagegen muss aber geltend gemacht werden, dass solche gemeinsamen chemischen Stoffe, wo sie überhaupt postuliert werden, auch in anderen Pflanzen nicht näher verwandter Familien vorkommen, ohne dass diese deshalb von den Larven gefressen werden. Ein Beweis dafür, dass solche chemischen Stoffe (Gerbsäuren, Saponine u. a.) von den Larven gesucht und besonders benötigt werden, dürfte noch schwerer zu erbringen sein. Wie eingangs bereits erwähnt wurde, wird vom Futter durch die phytophagen Insektenlarven vorwiegend das Eiweiss ausgenutzt, und in der Ähnlichkeit bezw. Verwandschaft des Eiweisses zeigt sich eben die Pflanzenverwandschaft. Am Anfang unserer Betrachtungen hatten wir eine Anzahl von Fällen mitgeteilt, bei denen die Oligophagie unzweifelhaft auf eine Verwandtschaft hinweist, die auch von den Botanikern nicht bestritten werden kann. Diese Fälle können beliebig vermehrt werden, und auch von Seiten der Botanik ist darauf hingewiesen worden, dass die parasitischen Pilze, soweit sie oligophag sind, sich an die Pflanzenverwandschaften ihrer Wirte halten, worauf besonders E. Fischer aufmerksam gemacht hat. Die zahlreichen hier angeführten Fälle lassen uns mit Sicherheit vermuten, dass zwischen den Familien der Amentiferae und den Rosaceae nähere verwandschaftliche Beziehungen bestehen, als sie im botanischen System zum Ausdruck kommen, und es kann schon jetzt vorausgesagt werden, dass einmal die Zeit kommen wird, in der von botanischer Seite mit den Arbeitsmethoden der Botanik eine solche Verwandschaft nachgewiesen werden wird.

Es darf hier aber nicht vergessen werden, dass die dargelegten Gründe für die Annahme einer solchen Verwandschaft keine Beweise für sie sind, dass sie aber für den Botaniker den Hinweis geben, nach solchen Beweisen zu suchen! Disjunctive Oligophagie, also nicht auf Verwandschaft beruhende Nahrungsauswahl dieser Art, ist nicht allzu häufig; wie die angeführten Beispiele zeigen, handelt es sich dann meistens um den Übergang auf eine andere Futterpflanze, die im gleichen Biotop vorkommt, so dass vielleicht der „Dunstkreis“ der normalen Futterpflanze dabei eine Rolle spielt. Der gemeinsame Biotop kommt hier bei den geschilderten Fällen aber nicht in Frage, zudem ist das gemeinsame Vorkommen an Amentiferen und Rosaceen eine so häufige und weit verbreitete Erscheinung unter den phytophagen Insektenlarven, und Biotop-Gemeinsamkeit scheidet in den meisten Fällen aus, so dass wir das hier geschilderte gemeinsame Vorkommen nicht als disjunctive Oligophagie ansprechen können. Dass Fütterungsversuche auch bei vielen Arten den Übergang auf andere Pflanzenfamilien unter Zwang erreichen, darf auch nicht als Gegenargument geltend gemacht werden, da viele Insektenarten wohl ausgesprochene Fähigkeiten zur Xenophagie besitzen, sie normalerweise aber nicht zu Tage treten lassen.

Mögen diese Ausführungen dazu beitragen, dass recht viele Entomologen weiteres Material zu diesem interessanten Teilgebiet der Oligophagie-Forschung beibringen, und dass von Seiten der Botaniker versucht wird, den Beweis für die hier postulierte Verwandschaft zwischen den Rosaceae und den Familien der Amentiferae zu erbringen.

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## ORIGINE ET ÉVOLUTION DES INSECTES

Par R. Jeannel

Pour reconstituer l'histoire des lignées des Insectes, on dispose de documents de deux sources différentes, les uns paléontologiques, les autres biogéographiques.

Les gisements fossilifères ont fourni des restes de milliers d'espèces. En 1925, H a n d l i r s c h en connaissait près de 10.000, et ce nombre n'a fait qu'augmenter. Malheureusement, une faible partie de ces documents se prête à des études de phylogénie. D'abord il est rare que l'on dispose d'individus fossiles complets. La plupart des empreintes ne montrent que quelques organes, le plus souvent des ailes; et on sait combien il est dangereux de baser des conclusions phylogénétiques sur la variation d'un seul organe.

En second lieu, plus que dans n'importe quel groupe d'animaux, les formes extérieures ont une importance capitale pour l'identification des Insectes. Or l'écrasement des échantillons fossiles a produit presque toujours des déformations qui rendent la détermination, même celle de la famille, à peu près impossible pour le spécialiste le plus averti. On est déconcerté devant l'audace des déterminations faites par certains paléontologistes.

En fait, il est possible de déterminer avec une certaine approximation les Insectes dont les ailes se fossilisent à plat, comme la plupart des espèces du Primaire, les Odonates, les Ephémères, les Névroptères. Mais il vaut mieux renoncer à utiliser les déterminations de Coléoptères fossiles, malgré leur abondance dans les gisements du Secondaire et du Tertiaire. Seuls ceux de l'ambre sont vraiment identifiables.

Cette carence de documents paléontologiques, en ce qui concerne le Secondaire et le Tertiaire, est amplement compensée par ceux qui sont fournis par les méthodes biogéographiques. Mais ici encore il est nécessaire d'agir avec circonspection.

Les documents biogéographiques éclairent puissamment l'histoire des lignées, lorsqu'ils découlent de revisions systématiques de groupes bien limités. Il faut tout d'abord avoir effectué l'étude taxonomique de toutes les espèces connues, avoir défini les caractères néogénétiques, produits par les évolutions des organes, et découvert les caractères paléogénétiques, hérités des souches. Ainsi les espèces actuelles sont groupées en lignées homogènes et c'est la distribution géographique actuelle de ces lignées qui permet de reconstituer leur histoire pendant les périodes géologiques. C'est la méthode que j'ai toujours suivie dans mes monographies de groupes divers, tels que les *Trechidae*, *Catopidae*, *Migadopidae*, *Henicocephalidae* et autres, monographies qui m'ont permis de présenter une synthèse de l'histoire du peuplement des continents dans un livre : *La genèse des faunes terrestres* (1943).

Par la combinaison des deux sources de documents, les uns paléontologiques, les autres biogéographiques, il est possible de se faire une idée précise de l'évolution des Insectes depuis leurs origines. Les fossiles permettent de reconstituer l'histoire des lignées du Primaire et du Trias. Les documents biogéographiques font remonter l'histoire des souches des lignées actuellement vivantes jusqu'au Trias. Entre les deux, au sommet de la série des documents paléontologiques, se trouve le fameux gisement fossilifère d'Ipswich, en Australie, datant du Trias supérieur et riche en formes synthétiques. Ipswich est en quelque sorte le trait d'union qui raccorde nos connaissances sur



les Insectes fossiles à celles que nous pouvons avoir sur l'histoire des lignées actuelles, d'après leur chorologie.

L'histoire des Insectes, comme celle des Plantes, dépend étroitement des changements survenus dans la répartition des terres et des mers au cours des périodes géologiques. Le domaine terrestre a été constitué, dès le Paléozoïque, par trois aires continentales très anciennes et permanentes, trois "asiles", caractérisés par l'absence de plissements récents et la rareté de transgressions marines (E. S u e s s). C'est naturellement sur ces asiles que la vie terrestre s'est développée. Ce sont : dans l'hémisphère septentrional la *Laurentie* et l'*Angarie*, dans l'hémisphère méridional la *Gondwanie*.

Entre le bloc septentrional formé par la Laurentie et l'Angarie et le bloc méridional de la Gondwanie, il s'est trouvé de tous temps une zone équatoriale instable, la zone *mésogéenne*, le plus souvent recouverte par la mer, mais soumise à des vicissitudes par lesquelles des communications terrestres ont pu se faire et se défaire entre les deux blocs, se prêtant à des échanges de faunes et de flores pendant certaines périodes.

Il est aujourd'hui démontré qu'il a existé de tous temps des climats variables selon la latitude. Mais leur répartition sur le globe s'est modifiée au cours des temps, sans aucun doute en fonction de la position des continents par rapport aux pôles. De ce fait, les asiles ont subi de lents changements climatiques. Ces changements ont influencé l'évolution des lignées et ont provoqué des migrations de faunes entières.

### *Succession des faunes d'insectes*

Pendant le Carbonifère, de nombreuses lignées d'Insectes ont évolué sur la partie de la Laurentie représentée aujourd'hui par l'Est des Etats-Unis et l'Europe occidentale, qui se trouvaient alors dans la zone équatoriale. Ce furent des Paléoptères et Polynéoptères, tous hétérométaboles, dont les ancêtres dévoniens étaient probablement venus de régions plus au nord et actuellement polaires.

A la même époque, une faune de climat tempéré ou froid s'est développée sur la Gondwanie. Cette faune gondwanienne fut principalement constituée par des Homoptères (Paranéoptères) et les Oligonéoptères, c'est-à-dire par les souches de groupes bien différents de ceux de la Laurentie. Elle a renfermé les souches de tous les holométaboles, c'est-à-dire de tous les Insectes à métamorphoses comportant une diapause nymphale, caractère d'adaptation en rapport avec des hivers froids.

A la fin du Permien, la Laurentie s'est refroidie, passant dans la zone tropicale aride; la Gondwanie au contraire se réchauffe, de sorte que les climats des deux asiles tendent à s'égaliser. Des retraits des mers de la Mésogée facilitent des échanges de faunes.

La plupart des lignées primitives des Paléoptères laurentiens, qui avaient vécu dans des forêts chaudes et humides, s'éteignent; mais quelques groupes de Polynéoptères, comme les Blattes, survivent. D'autre part les lignées gondwaniennes se répandent dans le monde entier; elles envahissent à la fois l'Angarie et la Laurentie, accompagnant dans l'hémisphère nord les migrations des Conifères et des Reptiles primitifs, parmi lesquels se trouvent les souches anciennes des Mammifères.

Ainsi, au début du Secondaire, les faunes entomologiques du monde entier se trouvent constituées par un mélange de lignées gondwaniennes nombreuses et de quelques survivants de lignées laurentiennes. Ces faunes évolueront pendant le Mésozoïque, sous l'influence des isolements produits par la fragmentation de la Gondwanie.

Leur histoire, à partir du Trias, il y a quelque 200 millions d'années, découle maintenant de la mise en œuvre des documents biogéographiques. Les lignées des Insectes

se classent dans un certain nombre de catégories, ayant chacune son histoire propre. Et ces catégories se groupent elles-mêmes dans trois principales, désignées comme lignées laurentiennes, lignées gondwaniennes et lignées angariennes. Car aux deux catégories anciennes, il s'en ajoute une troisième plus récente, celle des lignées angariennes, c'est-à-dire issues d'un peuplement de l'Angarie effectué, dès le Permien, par des souches gondwaniennes. Accompagnant les Angiospermes à partir du Crétacé moyen, ces lignées angariennes déferleront sur tout l'hémisphère nord pendant le Tertiaire.

L'histoire des lignées laurentiennes et gondwaniennes se déroule donc depuis le Paléozoïque; celle des lignées angariennes ne commence qu'au Crétacé. L'histoire des premières a pour théâtre le monde entier; celle des lignées angariennes se situe seulement sur l'ensemble des continents septentrionaux formant ce qui a été appelé la "Laurasie" par le géologue Du Toit et correspond d'ailleurs à peu près à la région holarctique des biogéographes.

#### *La faune laurentienne du Paléozoïque*

Les plus anciens Insectes fossiles connus sont des Collemboles, *Rhyniella praecursor*, du Dévonien moyen de Rhynie, en Ecosse. On sait ainsi qu'au Dévonien, les Aptérygotes devaient peupler la Laurentie. Selon toute vraisemblance, ce doit être au Dévonien que les premiers Ptérygotes ont développé des ailes, et que celles-ci ont évolué dans deux directions orthogénétiques, celle des Paléoptères, à ailes primitives, étalées à plat perpendiculairement au corps, et celle des Néoptères, repliant leurs ailes en arrière et développant sur les postérieures une *neala* (Martynov). Quoi qu'il en soit, c'est au Carbonifère supérieur que des lignées diverses de Ptérygotes apparaissent dans les gisements de houille de la Laurentie.

Tous ces gisements carbonifères, tant dans l'est de l'Amérique qu'en Europe occidentale, ont fourni les restes d'une flore manifestement développée sous un climat équatorial humide et chaud. La très riche faune entomologique accompagnant cette flore est formée de Paléoptères (Paléodictyoptères, Méganisoptères, Protéphémères) et de Néoptères primitifs, ou Polynéoptères (Protorthoptères, Protoblattoptères, Blattes). L'apogée de cette faune se place au Stéphanien, dans les gisements de Mazon Creek en Amérique, de Commentry en France.

Au Permien, le climat se modifie sur la Laurentie. La flore témoigne d'un climat tropical aride et les lignées d'Insectes du Carbonifère sont remplacées par d'autres, sans doute venues d'une autre partie de la Laurentie. Dans l'ordre des Paléodictyoptères, les Mégaséoptères sont remplacés par des Protohyménoptères différemment spécialisés. Les *Meganeura gigantesques* font place à des *Typidae* plus petits; d'autres familles de Blattes se substituent à celles du Carbonifère.

Les gisements d'Insectes fossiles du Permien sont répartis sur toute les terres laurentiennes, depuis le Kansas jusque dans la Russie. Ils ont fourni des restes de nombreux représentants de cette faune de Paléoptères et Polynéoptères autochtones. Mais avec ceux-ci se mêlent des lignées gondwaniennes de Paranéoptères et d'Oligonéoptères, qui ont franchi la Mésogée en divers endroits, et au sujet desquels nous reviendrons ci-après.

A la fin du Permien et pendant le Trias, la plupart de ces lignées de Paléoptères et de Polynéoptères, qui ont évolué sur la Laurentie, achèvent de s'éteindre. Presque toutes furent des essais évolutifs de groupes qui ont duré pendant les quelques 200 millions d'années qui s'étendent depuis le début du Dévonien jusqu'à la fin du Primaire. Seules les lignées des Blattes gardent toute leur vitalité.

*La faune gondwanienne permo-triasique*

Pendant la fin du Paléozoïque, la Gondwanie fut le centre d'évolution de lignées innombrables qui ont supplanté, sur l'hémisphère nord, les derniers Insectes laurentiens. Ces lignées gondwaniennes ne nous sont connues en place que de l'Australie orientale et des îles Falkland; mais il n'est pas douteux qu'elles aient évolué pendant le Carbonifère sur les parties tempérées de la Gondwanie.

Ces gisements australiens sont ceux de Belmont et de Newcastle, en Nouvelle Galle du Sud; ils datent de la fin du Permien. La faune qu'on y a découvert est formée principalement d'Homoptères (Paranéoptères) et de divers groupes d'holométaboles (Mécoptères, Névroptères); c'est-à-dire de groupes tout différents de ceux de la Laurentie. Les empreintes sont associées à des restes de frondes de *Glossopteris*, ce qui indique un climat très froid, subpolaire.

Cette faune n'est pas seulement connue de l'Australie. On la retrouve sur la Laurentie permienne, d'une part dans le Kansas, à Elmo (Permien inférieur), et d'autre part en Russie, dans la province de Kazan et à Arkangelsk (Permien supérieur). Il n'en apparaît aucune trace dans les gisements permien de l'Europe occidentale et cette répartition ne laisse pas de surprendre. Elle ne peut s'expliquer que de la façon suivante :

Les lignées d'Homoptères et d'Holométaboles, dont les restes sont conservés dans les trois groupes de gisements, dérivent de souches qui ont évolué au Carbonifère sur des contrées tempérées inconnues de la Gondwanie. Au Permien inférieur certaines ont pu franchir la Mésogée occidentale et atteindre le Kansas, en Amérique. Plus tard, au Permien supérieur, une deuxième migration, à travers la Mésogée orientale, a gagné la Russie, accompagnant la flore à *Pursongia* et les Reptiles gondwaniens qui ont atteint la Dwina. Les gisements de Belmont et Newcastle, en Australie, nous font connaître une partie de la descendance sur place des souches gondwaniennes qui ont donné naissance à ces deux migrations. La latitude subpolaire de ces gisements australiens a imprimé à leur faune un faciès particulier; beaucoup de lignées y sont absentes.

En Australie, le Trias fait suite sans transition aux gisements permien; la faune triasique d'Insectes succède à celle du Permien. Et le gisement d'Ipswich, dans le Queensland (Trias supérieur), montre une faune dérivée, bien plus riche, car le climat s'est réchauffé, avec des types plus évolués et de remarquables formes synthétiques. Les Homoptères, représentés par des Paléorrhynques primitifs dans les gisements permien, font peu à peu place aux Auchénorrhynques; des Hétéroptères apparaissent. Des Protodiptères à 4 ailes, dérivés des Paramécoptères, annoncent les Tanydérides et font la preuve que les Diptères ont perdu leurs ailes postérieures pendant le Trias. Des Névroptères primitifs seront les souches des familles, comme les *Kalligrammatidae* qui peupleront l'hémisphère nord au Jurassique. Les gisements australiens fournissent encore des précurseurs des Coléoptères (Permosynides), tandis que les premiers Coléoptères, les *Archostemata*, apparaissent en Russie dès le Permien inférieur (*Tschekardocoleus*) et au Permien supérieur (*Permocupes*).

Ajoutons enfin que la faune entomologique de la Gondwanie permienne a aussi compris des Paléoptères, dont les souches ont dû venir de la Laurentie à une époque très ancienne. On a vu que les Libellules laurentiennes ont constitué l'ordre des Méganisoptères, qui n'ont pas survécu au Lias. Mais les vrais Odonates se sont spécialisés sur la Gondwanie; on en connaît des traces en Australie et aux îles Falkland. A partir du Permien, leurs lignées ont gagné l'hémisphère septentrional par migrations successives, d'abord celle des Permodonates, puis celles des Néodonates pendant le Secondaire.

*La faune gondwanienne du Mésozoïque*

Les découvertes récentes des paléontologistes russes en Asie ont fait connaître de nombreux gisement liasiques par lesquels on voit la faune gondwanienne primitive se répandre dans l'hémisphère septentrional. Au Jurassique, on la trouve largement répandue en Europe. Mais les documents paléontologiques font totalement défaut sur toute la Gondwanie, de sorte que c'est exclusivement par les documents biogéographiques qu'il est possible de reconstituer l'histoire des lignées gondwaniennes qui s'est déroulée pendant le Secondaire sur les fragments du continent de Gondwana.

Ce sont surtout les Coléoptères qui vont dorénavant nous guider pour reconstituer cette histoire, parce que ce sont principalement des groupes de Coléoptères qui ont été l'objet de mes monographies. Mais qu'il soit dit une fois pour toutes que ce qui vaut pour eux vaut également pour tous les autres groupes d'Insectes. Je crois en avoir surabondamment fourni la preuve dans "La Genèse des faunes terrestres".

Toutes les lignées d'Insectes dont l'histoire remonte assez loin dans l'ère Secondaire se classent dans trois catégories : lignées *paléantarctiques*, lignées *africano-brésiliennes* et lignées *gondwaniennes orientales*. L'évolution de ces lignées au cours du Secondaire est facile à reconstituer dans le cadre de la doctrine de *W e g e n e r*, et on peut même dire que, par bien des points, elle apporte une démonstration de la réalité des rassemblements des socles continentaux gondwaniens, tels que les établissent les cartes paléogéographiques de *K o p p e n* et *W e g e n e r*.

*Lignées paléantarctiques.* — L'ouverture de l'océan Indien et de l'Océan Atlantique sud, qui a commencé au Jurassique supérieur et s'est prolongée pendant le Crétacé, a isolé la "Paléantarctide" (Australie, Antarctide et Archiplata) du bloc de l' "Inabrésie" (Inde, Afrique, Brésil) (*J e a n n e l*). Des lignées d'Insectes se sont différenciées dès le Trias sur la Paléantarctide. Les Archipanorpidés fossiles d'Ipswich sont encore représentés dans la faune actuelle par le *Notiothauma Reedi* du Chili. Ces lignées ont donné les souches de tous les nombreux groupes actuels qui sont étroitement localisés d'une part dans l'Australie et la Nouvelle-Zélande, d'autre part dans l'Amérique du sud. Les lignées paléantarctiques, de faune froide, ont pu se répandre dans l'hémisphère nord au Tertiaire, surtout par les Amériques.

*Lignées africano-brésiliennes.* — A la Paléantarctide s'oppose le bloc de l'Inabrésie, actuellement représenté par ses fragments : Brésil, Afrique, Madagascar, Arabie, Inde. Alors que la Paléantarctide était froide, subpolaire au Jurassique, le nord de l'Inabrésie se trouvait dans la zone tropicale. Des lignées d'Insectes de faune chaude s'y sont différenciées.

Nombreuses sont les lignées d'Insectes dites "africano-brésiliennes", qui ont pris naissance sur la partie occidentale de l'Inabrésie et se trouvent aujourd'hui réparties à la fois sur le massif brésilien et en Afrique. L'ouverture de l'Atlantique Sud, accomplie au Crétacé, les a séparées en deux tronçons qui ont évolué séparément, mais dont les affinités sont reconnaissables. Les éléments brésiliens de ces lignées se sont répandus dans l'Amérique du nord au Tertiaire; les éléments africains ont atteint Madagascar avant la fin du Crétacé et l'Indo-Malaisie au Montien.

*Lignées gondwaniennes orientales.* — Symétriques par rapport aux précédentes, ce sont les lignées de faune chaude qui se sont individualisées sur l'Inabrésie orientale. La plupart de leurs souches ont dû prendre naissance sur le massif indo-malais, et leur âge peut être daté d'après leur répartition actuelle sur le socle australien.

Les plus anciennes (lignées préjurassiques) ont envahi toute l'Australie et la Nouvelle-Zélande au Jurassique moyen (Postbathonien) et s'y trouvent encore de nos jours.

Les plus récentes (lignées postjurassiques) se sont individualisées après l'isolement du socle australien de la Malaisie; elles n'ont pu atteindre la Nouvelle-Guinée et l'Australie qu'au Pliocène et ne se trouvent guère aujourd'hui que dans le Queensland. Toutes ces lignées gondwaniennes orientales forment la majeure partie de la faune de la région Orientale, de l'Afrique orientale et de Madagascar; elles entourent l'océan Indien.

Un caractère remarquable des lignées gondwaniennes orientales est qu'elles se sont répandues dans l'hémisphère septentrional à la fin du Secondaire (Montien), d'une part vers la Chine orientale et le Japon, d'autre part sur la région méditerranéenne, en Europe méridionale et même au delà vers l'ouest, jusque dans les Iles Atlantides et dans l'Amérique du nord par la voie nord-atlantique. Le retrait de la Méditerranée orientale au Montien et le climat chaud régnant sur le nord de l'Europe a permis cette migration.

#### *La faune angarienne tertiaire*

Peuplée dès le Permien par des lignées venues de la Gondwanie primitive, l'Angarie a été, pendant tout le Secondaire, un vaste asile sur lequel les conditions climatiques ont été relativement constantes. Constituée par le socle asiatique entre le lac Baïkal et l'océan Arctique, soumise à un climat tempéré ou subtropical, elle a dû être un centre où se sont élaborées, pendant le Jurassique et le Crétacé, les souches des nombreuses lignées qui se sont répandues sur tout l'hémisphère nord pendant le Tertiaire.

Cette période de l'évolution des Insectes commence au Crétacé moyen, avec l'apparition des premières Angiospermes, c'est-à-dire des plantes à fleurs et à feuillage caduc. Cette flore apporte aux Insectes des possibilités nouvelles. Avec les fleurs et les fruits, surgissent des groupes nouveaux : Lépidoptères, Diptères Brachycères, Hyménoptères mellifères et prédateurs, Coléoptères floricoles, et dans les accumulations de feuilles mortes toute la faune saprophile prend un grand développement. Sans doute, la flore des Angiospermes et son cortège entomologique se sont-ils spécialisés sur l'Angarie pendant la fin du Jurassique et le Crétacé. Le fait est qu'on les voit apparaître en Europe dès que le retrait des mers méridiennes de l'Obi, à l'est de l'Oural, a ouvert un passage aux migrations venant de l'Asie (Montien).

Les premières migrations montiennes déferlent sur une Europe devenue pour la première fois continentale. Elles peuplent tout le nord et le centre européen et aussi la région méditerranéenne, où elles se mêlent aux lignées gondwaniennes orientales, venues par l'Arabie et l'Egée méridionale. Ainsi se constitue la faune méditerranéenne, particulièrement riche et diverse.

L'Eocène, avec la grande transgression du Lutétien, remet l'Europe à l'état d'archipel. Les lignées angariennes se retirent dans le nord (lignées arctiques) et d'autre part se réfugient sur les massifs hercyniens : Bohême, Egéides, Massif Central français, Tyrrhénide, qui deviennent autant de centres d'évolution d'ou partiront, au Néogène, les peuplements des chaînes de montagne du système alpin.

A partir de l'Oligocène, lorsque l'Europe reprend définitivement un régime continental et que la mer, revenue pendant l'Eocène sur l'Asie occidentale, s'est de nouveau retirée, les migrations venant de l'Angarie reprennent et se succèdent pendant tout le Néogène, jusqu'au Pliocène pour constituer la faune européenne actuelle. Les plus anciennes, à l'Oligocène, atteignent même l'Est américain.

Dans la région méditerranéenne, l'histoire des lignées d'Insectes a pu apporter des précisions particulières sur les vicissitudes paléogéographiques de cette région instable. Elle montre comment les lignées méditerranéennes, d'abord répandues sur toute la "Mésogéide" montienne, depuis le Caucase jusqu'aux Pyrénées, se sont localisées après le Lutétien d'une part sur les Egéides, d'autre part sur la Tyrrhénide. Elle fait apparaître aussi le rôle prépondérant joué par la barrière du Sillon Transégéen dans le peuplement de l'Europe occidentale. Au Pontien après l'assèchement des mers du Sillon (Tortonien), toutes sortes de lignées, auparavant enfermées sur l'Egée méridionale, se répandent librement vers l'ouest, accompagnant l'arrivée des grands Mammifères dits de la faune malaise et de la faune éthiopienne.

Telle est, très brièvement résumée, l'idée qu'il faut se faire des origines et de l'évolution des Insectes. Dans ce rapide exposé je n'ai pas pu entrer dans le détail des démonstrations des faits qui ont été exposés. On les trouvera tout au long dans "La Genèse des Faunes terrestres".

Pour conclure, je veux seulement souligner l'importance de l'entomologie en tant que science historique. Les innombrables lignées d'Insectes, dont l'évolution se déroule depuis les premières périodes du Primaire, peuvent fournir de précieux documents sur l'histoire des continents. Elles éclairent particulièrement celle des époques géocratiques, sur lesquelles la stratigraphie des géologues, basée sur les fossiles marins, ne donne guère de renseignements. Ainsi les deux disciplines, entomologique et stratigraphique, ne peuvent que se compléter heureusement pour parfaire nos connaissances sur les vicissitudes paléogéographiques du globe terrestre.

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## ON CHARACTERISTICS COMMON TO ALL KNOWN SPECIES OF SUCTORIA AND SOME TRENDS OF EVOLUTION IN THIS ORDER OF INSECTS

By *H. E. Karl Jordan*

As the famous Swedish Entomologist De Geer was the first to recognize that the insects which are the subject of this paper form a separate Order it seems to me very appropriate that I should use for this Order the name Suctoria given to it in the Latin version of De Geer's classification published by Retzius in 1783.

The discovery early in the present century that the Bubonic Plague is a rat-disease transmitted to man by rat-fleas placed the Suctoria among the medically important insects along with the mosquitoes and greatly stimulated research in the bionomics of those species which became known to be carriers of diseases or were suspected to be instrumental in the spread of epidemics.

The Suctoria stand isolated among the Orders of insects with complete metamorphosis and the various attempts to link them with some other Order remained unconvincing for want of sufficient evidence. The recent discovery by Sharif that the pupa of a flea has wing-cases on the mesothorax leaves no doubt that the Suctoria are related to, or perhaps descended from, one of the holometabolous Orders: Coleoptera, Diptera, Hymenoptera, Lepidoptera, Mecoptera, Neuroptera or Trichoptera. The problem of the origin of the Suctoria can, in my opinion, be successfully investigated only by the combined efforts of specialists in these various Orders. Our time appears to me specially favourable for the undertaking because the inquiry would be greatly assisted (1) by the detailed study of the morphology of the exoskeleton of fleas lately published by Snodgrass, (2) by the catalogue of *Pulgas* by Costa Lima & Hathaway, in which some 1300 species and subspecies are listed, with the literature referring thereto, and (3) by the Charles Rothschild collection of fleas in the British Museum (Natural History) at Tring being available for inspection. Moreover, material of common species of fleas has accumulated in various Museums and Hygienic Institutes, from which specialists who have no flea-collection for comparison with their own speciality could be supplied. An inquiry of the kind suggested will take time and I propose therefore that the organization of a Symposium be taken in hand at once with a view that papers on the subject will be ready for the next Congress. The present paper is introductory and has the object to convince specialists in other Orders than Suctoria that their cooperation is greatly required, the Leitmotif of what I am going to say being a repeated confession of ignorance.

The enquiry into the ancestry of any animal consists of the study of palaeontological records and recent specimens. In the case of fleas Palaeontology is of little help. The oldest known flea was found in Baltic amber. The species is a *Palaeopsylla* so similar to recent specimens (fig. 4) that the late Alfons Dampf discovered differences only after a minute examination. Incidentally I may mention that Charles Rothschild declined to buy the specimen; the price asked was £1200. *Palaeopsylla* being a very specialised genus, the Suctoria evidently arose at a much earlier period in the existence of life. No records of other extinct species of fleas being extant we have to rely for a partial reconstruction of the ancestral flea on what we can learn from its recent descendants.

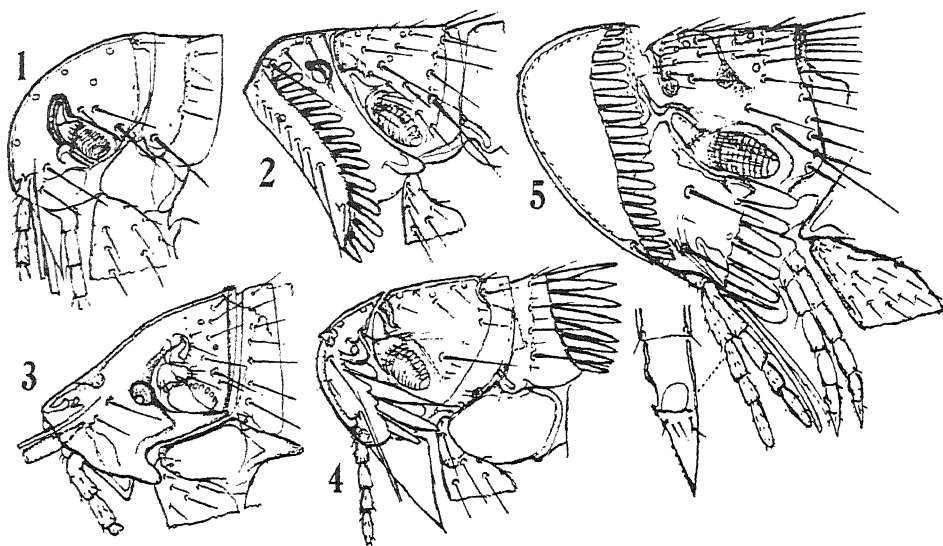


Fig. 1. *Praopsylla powelli* Ingram 1927, ♀ . — 2. *Epirimia aganippes* Roths. 1904, ♀ . —  
 3. *Hectopsylla cypha* Jord. 1942, ♀ . — 4. *Palaeopsylla minor* Dale 1878, ♀ . —  
 5. *Craneopsylla wolffhuegeli* Roths. 1909, ♀ .

I know that the students of Suctoria are greatly indebted to at least one member of the meeting, who has discovered a number of new fleas in far away districts. The majority, however, may be assumed to have made the personal acquaintance of only one species and perhaps even none, and may well be surprised at the great diversity between many of the fleas. Some of the heads here presented look almost grotesque (fig. 2, 5). But the strange distinctions are only superimposed on a common ground-plan. The head of a flea is more or less compressed like the whole body and divided by the deep groove (in which lies the antenna at rest) into a fore head and a back head, conveniently called frons and occiput. This division obtains in all fleas and is characteristic of the Order. The frontal portion of the head carries ventrally the mouth-parts of which the bases are overlapped in all fleas in consequence of the downward extension of the side of the anterior head, the ventral margin being often shifted far below the anterior ventral corner of the frons. In some genera, f.i. *Stenoponia* (fig. 9) and especially *Chimaeropsylla* (fig. 7), the bases of the mouth-parts are nearer the dorsal than the ventral margin of the head. The component parts of the feeding apparatus are always the same in kind in the Suctoria, but their length and width are liable to great variation. They were described in detail by Kraepelin (1897), who found the sucking apparatus of the fleas to agree closely with that of the Diptera. As according to Kraepelin the special features of this apparatus are found in no other Order but flies and fleas, he concluded that the Suctoria were derived from the Diptera. Kraepelin had seen all there was to be seen. Recent researches, however, have thrown doubt on the interpretation of what he saw and figured. That he did not recognize the upper lip, dismissing the small sclerite which is the upper lip (present in all fleas) as a connection of the epipharynx with the head-capsule, is of little



importance. His mistake was the identification of the pair of stilettos (posterior to the epipharynx) with the mandibles of flies, whereas Snodgrass has recently found them to belong to the maxillae, the imago-flea being without mandibles. This discovery upsets Kraepelin's conclusion. But there is the possibility that what is called mandibles in Diptera are also stilettos of the maxillae, which would render Kraepelin's conclusion valid again. The question should be cleared up by the comparison of the component parts of the sucking tube of the mosquitos, especially of primitive species, with those of the Suctoria.

The sucking tube at rest is enclosed in a sheath provided by the pair of labial palpi, the whole apparatus forming the rostrum or proboscis of the flea. The component parts of a rostrum are, of course, of equal length, but the rostra vary very much in length in different fleas. The maxillary stilettos are broad and strongly serrated to near the base in a number of fleas, among them the stick-tight fleas, in which they have acquired an additional function, fastening the flea securely to the host, so that rubbing and scratching on the part of the host may break all the legs of the flea but do not easily dislodge the parasite. The broad stiletto, which is sometimes about half the length of the body, for instance in *Hectopsylla stomis*, is surely a later modification of the slender stiletto with the teeth confined to a short apical portion. In contradistinction to the maxillary palpi, which always consist of four segments in fleas, the labial palpi are very variable in length and segmentation as well as in sclerotisation. The number of segments does not strictly depend on the length of the proboscis. In the stick-tight fleas the labial palpi are feebly sclerotized and have few segments; in *Pulex* and allied genera the usual number of segments is four, reduced in the European rabbit-flea to two (fig. 6); the *Ceratophyllidae* have five segments even in species with the proboscis extending far below the base of the fore femur, the number five recurring in the segmentation of the labial palpi in many other fleas. Taking the whole Order of Suctoria the extent of the variation of the labial palp is from one to twenty-five segments, see fig. 8 (*Dorcadia dorcadia*) and fig. 9 (*Stenoponia tripectinata*). The higher and lower numbers of segments are often different either individually or in closely related species, whereas the division into five segments persists in many genera, which suggests that five is a more ancestral number of segments than the lower and higher numbers. As an example of the acquirement of a second function by the labial palpi in *Craneopsylla wolffhuegeli* and some allied genera of South American fleas the enlargement of the tip of the labial palp is added to fig. 5; the last segment is sharply pointed in these fleas and bears at the anterior margin sharp teeth, the palp being evidently employed as an auxiliary piercing organ.

The faceted eyes of other insects are replaced in fleas by ocelli. In a few species the ocelli have become enlarged (f.i. in *Ceratophyllus macrophthalmus*), and in a large number they have become reduced, being sometimes entirely absent. Their position is normally low down at the anterior margin of the antennal groove; but the development of a genal comb often affects the position, tending to move the ocellus upwards, being left isolated in one instance (fig. 2, *Epirimia aganippes*) between the antennal groove and the vertical comb.

The structure of the antenna is as characteristic of fleas as is the groove that shelters this sense-organ. It always consists of two segments and a segmented club connected with segment two by a pedicel, and bears a superficial resemblance to the antenna of clavicorn beetles. The club inclusive of its pedicel consists generally of ten segments, never more, the number being reduced and the segments more or less amalgamated in

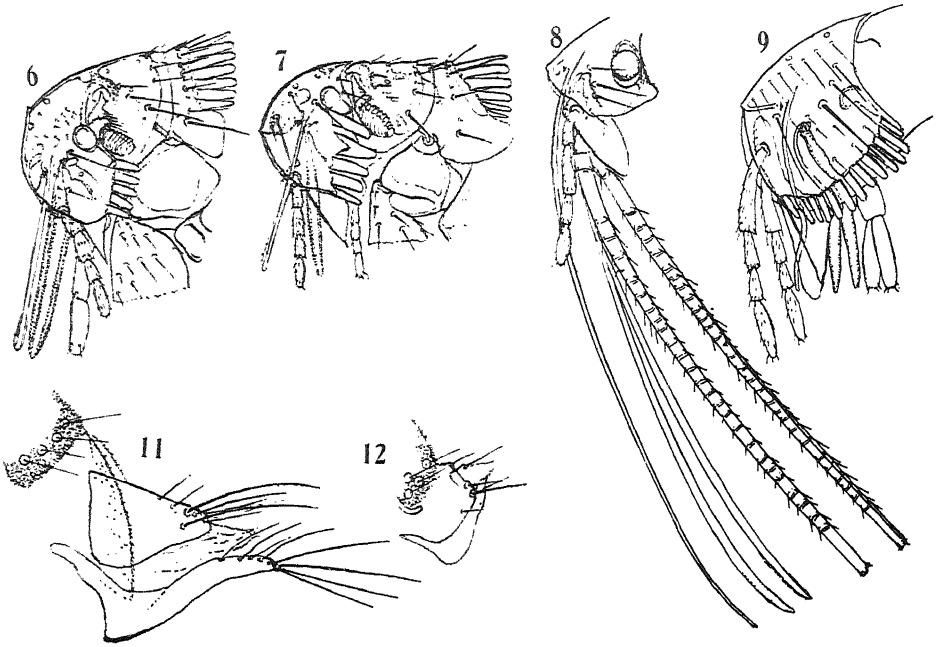


Fig. 6. *Spilopsyllus cuniculi* Dale 1878, ♀ . — 7. *Chimaeropsylla potis potis* Roths. 1911, ♀ .  
 Fig. 8. *Dorcadia dorcadia* Roths. 1913, ♀ . 9. *Stenoponia tripectinata* Tirab. 1902, ♀ .  
 Fig. 11. *Dasypsyllus g. gallinulae* Dale 1878, ♀ . — 12. *Xenopsylla cheopis* Roths. 1903, ♀ .

the stick-tight fleas. It is usually conspicuously longer in the male than in the female and has in such fleas acquired a secondary function discovered by Professor O. Lundblad, the antenna being used by the male to capture and hold the female. Being inserted at the top of the antennal groove with a pivot, the antenna can only be moved from backwards to upwards, never forwards, and offers therefore considerable resistance to the legs of the female when it tries to move forward and away. I do not know whether the antenna is similarly used in some Clavicornia. In the Anthribid genera *Xenocerus* (Oriental) and *Deuteroerates* (African) the long antenna of the male cannot be moved upward over the head, only side-, down- and forward, it is usually held forward and if placed over the female would effectively prevent its escape. The habit described by Professor Lundblad may not be general in fleas, nor can we know as yet with certainty that it has been acquired independently in fleas and some beetles.

The flea of the Mediterranean African porcupine has been selected for a sketch of an entire female (fig. 10, *Pariodontis riggenbachi*), because the species is large, pale, has comparatively few bristles on the body and no combs, and for these reasons shows some flea-characteristics more plainly than does a hairy species possessing many combs. I draw your attention to three pale spots placed along the margin of the frons and three on the occiput arranged in a triangle. They are comparable to the cornea of an ocellus and occur in all fleas I have seen except a few in which the surface of the head is disturbed by a considerable modification of its structure. A similar but smaller organ is found in all fleas at the base of all tibiae near the anterior margin on

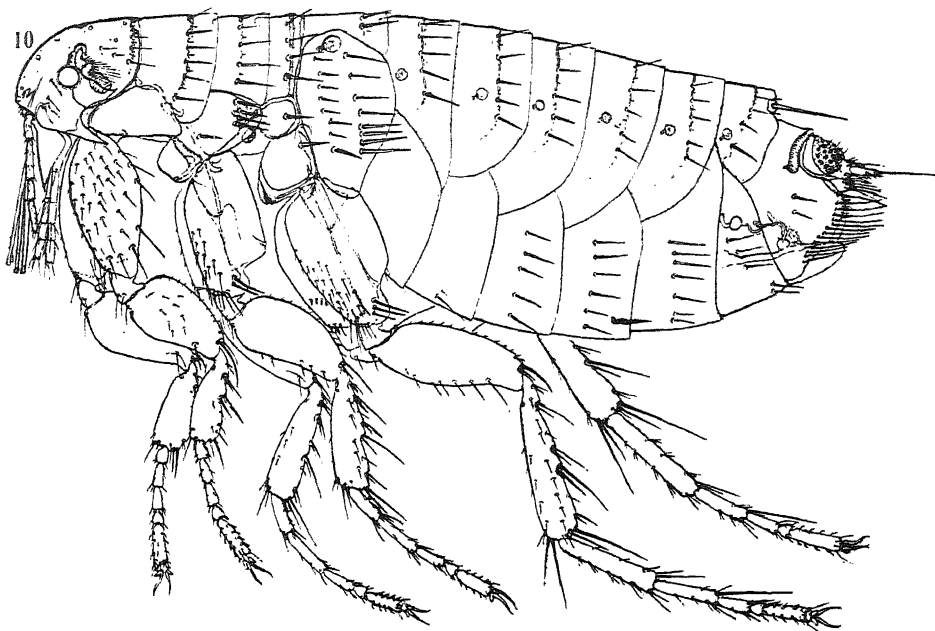


Fig. 10. *Pariodontis r. riggenbachi* Roths. 1904, ♀ .

the outer as well as the inner surface and less distinct organ of this kind is placed near the second dorsal notch, again on both sides; these placoid-like structures are presumably also sensorious. Whether these little organs are of any great importance in the life of a flea, we do not know. Their persistency throughout the Order gives them significance and they may be of assistance in the enquiry into the origin of fleas. One of the most important characteristics of Suctoria is well shown in *Pariodontis*: the great uniformity of the segmentation of the thorax and first seven segments of the abdomen. If we consider that the anterior end of the body provides for the continuity of life in the individual and the terminal segments take care of the continuity of the species we must expect to find in a wingless insect greater and more trenchant modifications at both ends than in the segments in between the extremes. The segmentation is more primitive than in other holometabolous Orders, which hints at the possibility that the Suctoria are derived from an extinct Order. Thorax and abdomen have other conspicuous distinction, some of which may be primitive. The prosternosome (the entire ventral body of the prothorax) is not divided by sutures, never bears bristles, which is note-worthy, is always contiguous with the head and carries at or just below the anterior angle each side the coxa; the under side is broader than in the mid and hind coxae, which gives the fore coxa greater freedom of movement. The mesosternosome has no external sutures except the one separating off the sternum, whereas the sternosome of the metathorax clearly shows the usual division into sternum, episternum and epimere (often misnamed epimeron). The epimere is exceptionally large and a characteristic feature of the flea-body. It has puzzled the early students of fleas very much and was almost generally regarded as being part of the abdomen.

As it is largest in the most strongly modified fleas, the *Tungidae*, it appears reasonable to assume that it was smaller in the ancestral flea than it is in the recent ones.

The sternum of segment I of the abdomen is absent; perhaps the small rod-like vinculum of the *Pygiopsyllidae* and *Neopsyllidae* is a remnant of it. The second sternum, therefore has a basal position. It overlaps its tergum in all fleas. In the female the sternum of VII likewise overlaps the tergum but not in the male. Tergum VIII is usually divided in the median line and is always large in the female, whereas sternum VIII is small, Sternum IX of the female is membranous and continuous with the dorsal wall of the oviduct, it sometimes bears a row of hairs and in some genera a lateral or subdorsal sclerite. The softness of sterna VIII and IX permits expansion of the oviduct for the passage of the large eggs. The centre of tergum IX is occupied by a large sensory organ (sensillum) in every known flea. It bears on each side from 8 to over 50 pits from which arises one thin longish hair each. The organ is conspicuous and very characteristic of the Order. Professor E. Martini has discovered a similar organ in some Staphylinid beetle which convinced him of a near relationship between Coleoptera and Suctoria. The evidence has not generally been accepted as conclusive, and it is much to be desired that Martini's line of research will be continued. There may be other evidence connecting Coleoptera with Suctoria. The anal stylet present in the females of nearly all species of fleas bears a close resemblance to the genital palp of female Coleoptera. The organ is short and undivided in both Orders.

The Suctoria have invariably ten stigmata, of which those of the abdominal segments II to IV are reduced to minute remnants in the females of *Tunga*. The first stigma is carried by a small sclerite situated between the pro- and mesothorax, the posterior end of this sclerite fitting into a niche at the anterior ventral corner of the mesonotum. The second stigma lies between the meso- and metathorax below a similar small sclerite the end of which fits into a niche of the metanotum. These small sclerites do not seem to have been noticed in other Orders. The first abdominal spiracle is always shifted on to the metepimere. The stigma of segment VIII is larger in nearly all fleas than the other stigmata and its cavity is often much enlarged. Only in a few genera is the last stigma of the same shape and size as the others, f.i. in *Vermipsyllidae*, which may mean that it is more primitive than the last stigma of the great majority of fleas.

I have above mentioned modifications of some posterior segments of the female which have arisen in connection with sexual functions. The corresponding modifications of the male are much greater and more complicated. Segment IX in particular is partially turned into auxiliary claspers nearly as in Lepidoptera and Trichoptera. The claspers retain the surface-structure of the exoskeleton and carry bristles of various kinds, whereas the central male-organ and its auxiliary parameres never have setae. The anal segment of Suctoria does not form part of the clasping arrangements; it remains a simple segment, often short (fig. 12, *Xenopsylla cheopis*), and its sternum is frequently divided ventrally in the middle line (fig. 11, *Dasypsyllus g. gallinulae*) as is sternum IX in many males. Neither the tergum nor the sternum is turned into naked hooks as in Lepidoptera. This primitive state of segment X appears to exclude the Lepidoptera from the ancestry of the Suctoria.

The strong sclerotisation of the metathoracic ridges probably has arisen in connection with the jumping habit of fleas. The persistence of the ridges in species which jump very little or not at all suggests that the sclerotisation is inherited from an ancestor which was a jumper rather than a crawler. The legs hanging down from the thorax

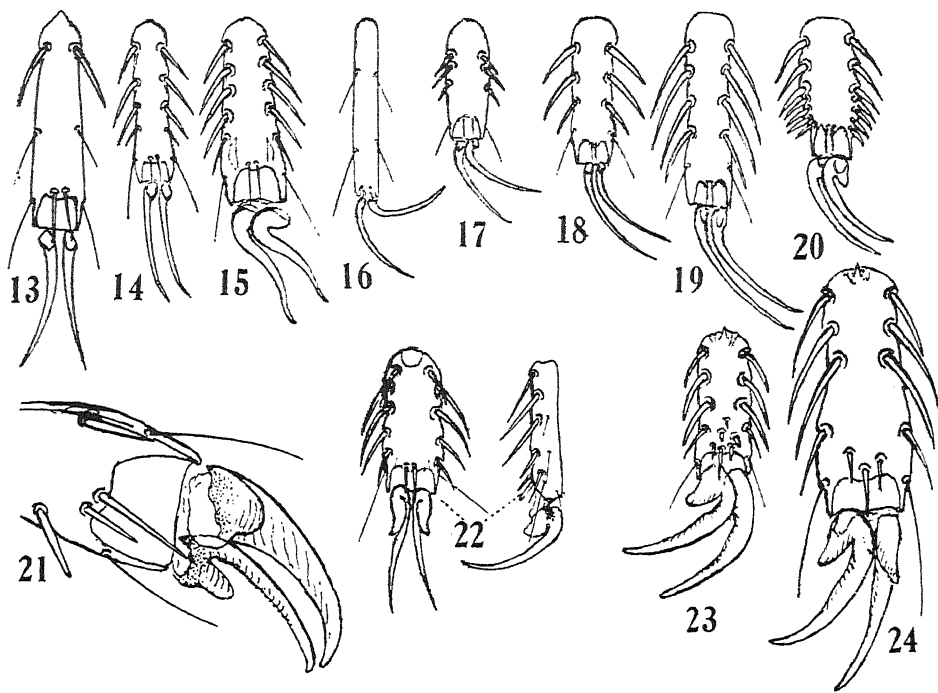


Fig. 13. *Echidnophaga liopus* J. & R. 1906, ♀. — 14. *E. gallinaceus* Westw. 1875, ♀. — 15. *E. macronychia* J. & R. 1906, ♀. — 16. *Tunga penetrans* L. 1758, ♀. — 17. *T. caecigena* J. & R. 1921, ♀. — 18. *Hectopsylla gemina* Jord. 1839, ♀. — 19. *H. coniger* J. & R. 1906, ♀. — 20. *H. psittaci* Frauenf. 1860, ♀. — 21. *Rhopalopsyllus lutzi* Baker 1904, ♀. — 22. *Nosopsyllus fasciatus* Bosc 1801, ♀. — 23. *Ctenocephalides connatus* Jord. 1925, ♂. — 24. The same, ♀.

have many specializations common to all fleas, some of which may be expected to recur in other insects, as for instance the division of the outer and inner surfaces of the mid and hind coxae indicated in fig. 10 and 25. The number and length of the bristles are frequently of taxonomic importance and their variation often indicates lines of evolution. The variation of the end-segment of the fore tarsus may serve as an example. The tarsi of fleas have always five segments. The fifth (fig. 13—24) bears on the under side along the lateral margins a row of short, almost spiniform, bristles which are curved downward-distad in nearly every flea, exceptions being found among the stick-tight fleas. These plantar bristles are usually constant in a species and often different in allied species. The specific variation of three species of *Echidnophaga* is shown in fig. 13—15, which speak for themselves. In the Chinese *Tunga* (fig. 17) there are three plantar bristles and in the five American only some long slender hairs (fig. 16). In the three *Hectopsylla* (fig. 18—20) we see three, four and seven plantar bristles (in the collection we have also specimens and species with five and six). Which was the original number of plantar bristles of the stick-tight fleas? If we turn to other fleas to find an answer, we observe that in a large number of species there are persistently five, as in fig. 22 (*Nosopsyllus fasciatus*). In *Ctenophthalmus*

the variation is from five to three plantar bristles, the hind tarsus having often one plantar bristle less than the fore and mid tarsus and a right tarsus may have four and the left one five, or even the two rows of the same fifth segment may differ in that way. There is here indicated a trend to reduction, and as fewer than ten known species have more than five plantar bristles each side of segment V whereas the number of species with fewer than five is large, the trend is fairly general, the lesser number of plantar bristles representing a later stage of evolution than the greater number of the allied species. The greater number of bristles in fig. 20 (*Hectopsylla psittaci*) was probably acquired after the flea had become definitely a parasite of birds, but *Lycopsylla* and *Coptopsylla*, with more than five bristles, are rather primitive in several characteristics and might with justification be regarded as supporting an assumption that the ancestral flea had more than five plantar bristles.

At the end of the sole of segment V there are two small bristles (sometimes only one, sometimes three, four or more) which occur in every species of flea. They remind one of the empodium or pulvillus of other insects, but are placed on the segment itself, being in fact derived from the small hairs found frequently scattered over the sole of the segment. It is a minute flea-distinction for which one should look in other insects as well. In a number of species these ventral apical bristles differ in the sexes, as shown in fig. 23 (male of *Ctenocephalides connatus*) and fig. 24 (female of the same).

The double claw carried by segment V has normally a large basal tooth, as in fig. 20 (*Nosopsyllus fasciatus*). In the most specialized stick-tight fleas the tooth disappears (fig. 13, 14, 16—19), corroborating the evidence of reduction presented by the plantar bristles. In a limited number of fleas the claws are unsymmetrical (fig. 21, *Rhopalopsyllus lutzi*).

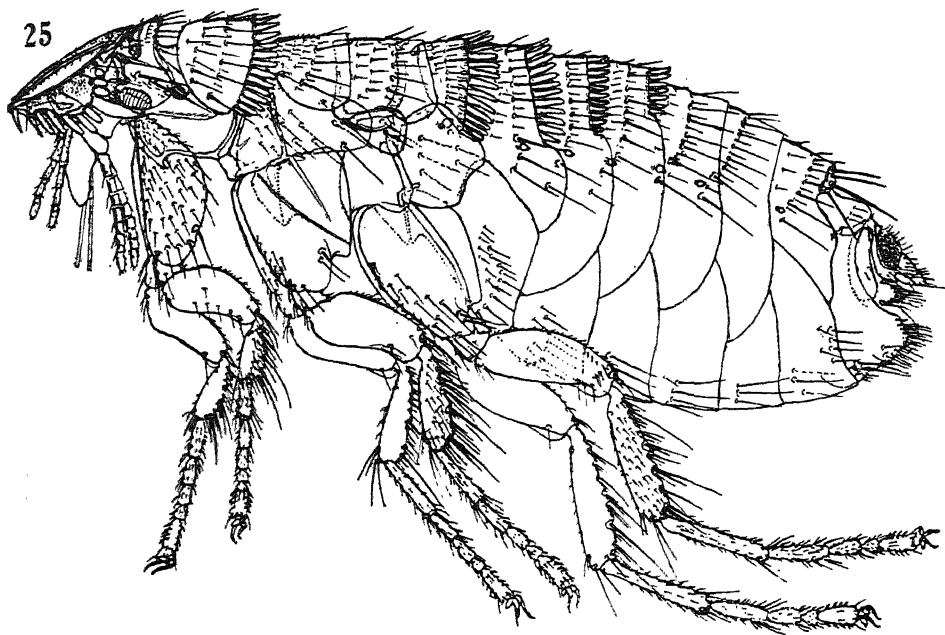


Fig. 25. *Stephanopsylla thomasi* Roths. 1903, ♀ .

As combs are a prominent feature of many fleas the sketch of a comb-bearing flea (fig. 25, *Stephanopsylla thomasi*) illustrates some characteristics of Suctoria not seen in the combless *Pariodontis* (fig. 10). The head of this Australian flea (of which only one specimen is known) is most peculiar, combining characters of bat-fleas and helmet-fleas. The distribution of combs on the body is interesting: they occur only on the frontal section of the head and on the dorsum of the thorax and abdomen, the highest number of combs or remnants of them is nine (*Uropsylla* and *Stenischia*), not including the head. Why there is never a comb (apart from marginal serration) on the occiput and the abdominal sterna remains a puzzle. The mesonotum also never has an external comb; but here the comb is represented by the pseudosetae which are found in many fleas on the under side of the collar of the mesonotum. These setae never develop into a comb, but if the mesonotum is injured in larval life one or the other of the pseudosetae may develop into a spine similar to but smaller than a spine of the pronotal comb. Another puzzling character is very clearly shown by this hairy flea. The posterior row of bristles of the thoracic and the anterior seven segments has small bristles regularly placed between the long ones. These intermediates occur in all fleas (also in the posterior row of the occiput), except in species where a great reduction of bristles has taken place (stick-tight fleas, for instance). Like the combs they are never present on the abdominal sterna and they have been discovered in a row anterior to the last one only on the occiput of a very strongly modified species of bat-flea. Why are these intermediates so persistently confined to the posterior row? What is their function? One could speculate more profitably on such problems if we were not so ignorant about the morphology of the ancestral flea.

Some of my young friends and colleagues in the study of Suctoria are very keen to find a solution of the puzzling questions of phylogeny and evolution. I sincerely hope that we shall succeed in organizing cooperation with specialists in other Orders with the object that each member of the Symposium will report to the IXth Congress of Entomology on that section of the enquiry in which results have been attained by him or her. A discussion of the Origin of the Suctoria would then be most interesting and instructive. In conclusion I venture to suggest that it will interest the fair sex present at this meeting that the male flea has one more ganglion than the female and that his nervous system therefore is regarded as being of a more primitive type.

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PROGRESS IN THE CONTROL OF *Hypericum* BY INSECTS

By A. J. Nicholson

St. John's wort, *Hypericum perforatum*, appears to have been introduced to Australia about 1880 from Europe. Since then it has progressively spread, and it is estimated that it now occupies about half a million acres of country. The infested areas are mainly in Victoria and New South Wales, but also occur in South Australia, Western Australia and Tasmania. St. John's wort is a serious pest of grazing land and has some importance also in cultivated areas. While pasture improvement has been shown to be a means of control, this is not practicable over most of the hilly area occupied by the weed.

St. John's wort not only greatly reduces the carrying capacity of large areas of country but also has an adverse effect on grazing animals. When this weed represents a high proportion of the food eaten, animals develop a condition of photo-sensitivity, unpigmented areas of the skin become inflamed under the influence of sunlight, and later sores and scabs develop. This causes considerable loss in the condition of the animals and sometimes leads to death.

St. John's wort can be suppressed by heavy applications of common salt, and this material has been used widely to restrict the spread of the weed along stock routes and roads. However, to treat the whole of the infested area by such chemical means would be quite uneconomical. The suggestion therefore was made many years ago that attempts should be made to control it by biological means, and the success obtained by the use of *Cactoblastis cactorum* for the control of prickly pear gave great weight to the argument in favour of using this method.

When the Division of Economic Entomology of the Commonwealth Council for Scientific and Industrial Research was established in 1928, Dr. R. J. Tillyard selected this as one of the first problems to be undertaken. Mr. S. Garthside was sent to the Farnham House laboratory, England, to study the insect enemies of St. John's wort there. He selected the most promising insects, and carried out extensive tests to find whether or not it would be safe to introduce these into Australia. He sent a number of different species of insects to Australia, accounts of which have been published elsewhere (2). In this address I shall confine attention to those insects that subsequently became established in the field in Australia. In 1935 Mr. F. Wilson was stationed at Hyères, on the Mediterranean coast of France, as it was considered that insects occurring in that region might prove better adapted to conditions in Australia than the English insects, for the climate in most of the infested areas in this country resembles more closely that of the Mediterranean Region than the English climate.

The first insect to become established in the field in Australia was *Chrysomela hyperici*, a number of liberations of which were made in the period 1931—34. The beetles re-appeared in 1939 at a point where this species had been liberated last in 1934. During the intervening period it was thought that the insects had died out, but apparently a few had survived and become adapted to local conditions. Since then the beetles have progressively increased in abundance and they have spread out from this point.

In 1942 *Chrysomela gemellata* was recovered at places where liberations had been made in 1939. This species appears to be better adapted than *Chrysomela hyperici* to Australian conditions, and has increased and spread much more rapidly. In many



places where the two species have come in contact it appears likely that *C. gemellata* will suppress *C. hyperici*, but there are indications that *C. hyperici* is better adapted to certain areas, particularly those in which there are many trees shading the undergrowth.

The Buprestid beetle *Agrilus hyperici* was sent to Australia from France in 1939—40, and has become established in the field at several points. Although this insect has become established no great increase in numbers or spread has been observed, and it appears probable that this insect also is likely to be suppressed by *C. gemellata*.

The Chrysomelid beetles have shown a very impressive ability to clear areas of St. John's wort and to maintain them free for several years at least. The attack of these insects is often most spectacular. Although the adult beetles are able to fly they do not do so readily. The result of this is that around a point of liberation one frequently finds a very definite front of advance, behind which practically all St. John's wort has been completely eaten out, and in front of which few beetles exist and there is little visible damage. The front itself is only two or three yards in depth and the beetles are so numerous there that when viewed from a distance the front is seen as a definite dark line. This concentration of adult beetles makes collection for further distribution particularly easy: a bucket can be filled with beetles within a few minutes by simply knocking them into it by hand.

In summer the adult beetles live mainly on the erect plant growth and they consume all of the softer tissues: leaves, buds, flowers and the cortex of the stems. Often, after they have attacked a plant, the only remaining portion is the hard woody centre of the main flowering stalk. In winter and spring, on the other hand, the adults and larvae feed on the procumbent growth of the St. John's wort, and when present in numbers they consume practically everything above ground. Following this destruction of the above ground portions of the plant by both adults and larvae, there may be some regrowth from the roots, but this is always quickly attacked by the insects and, with *C. gemellata* at least, even in areas which have been cleared of St. John's wort for some time, there appear to be sufficient insects left to deal with any regrowth or seedlings that may appear.

Although the most obvious method of spread is as I have just described, the beetles do at times fly, and frequently they have been observed at numerous points far from any known point of liberation. The insects are now well established over many square miles of country, and they have already cleared many hundreds of acres. The history of the spread of the insects since their introduction shows clearly that there has been a progressive increase in the size of the new area cleared each year. It is only necessary for these insects to increase as they have done in the past to reach the point in a few years at which most of the infested areas in open country will be cleared. In infested open forest country, however, the beetles have produced less spectacular effects on the St. John's wort, and it is too early yet to judge whether or not they are likely to prove equally effective there.

The position seems to be almost equally promising in other countries into which insects have been introduced for the control of *Hypericum perforatum*. In 1943 a consignment of 30,000 *C. hyperici* was sent from Australia to New Zealand, and during the period 1944—47 mixed consignments of *C. gemellata* and *C. hyperici* totalling 650,000 and 3,500 *Agrilus hyperici* were sent to California. From both of these countries most encouraging reports have been received showing that the insects have

not only become well established but are already producing spectacular effects on the weed.

From what has already been said it is clear that the prospects of obtaining effective control of St. John's wort by means of insects are very good. I think it is appropriate that I should here make a plea for the wider use of insects for controlling weed pests. There has been an understandable reluctance in many countries to introduce phytophagous insects to control weeds, but after many years of experience in using this method in Australia we feel that the danger to crops has been over-estimated, and that if proper precautions are taken when deciding which insects to introduce, the danger can be reduced to a permissible level. On the other hand, when one considers the small number of weeds against which insect enemies have been used, the number of successes is surprisingly large: the proportion of successes to attempts is far larger than has been obtained with the introduction of natural enemies to attack insect pests.

The number of attempts to control weeds by means of insects is so small that it is worthwhile referring to them individually now. The first use of the method is credited to Koebele who, in the early years of this century, introduced *Lantana* insects from Mexico to Hawaii (5). This classical work did not meet with notable success, but there is reason to think that greater success might have been obtained had the introduction of insects been pursued further. Apparently the method was first used in Australia when *Dactylopius ceylonicus* was introduced to attack the tree pear, *Opuntia monacantha*, a minor pest in Queensland. Shortly after the introduction of this insect the cactus plants quickly collapsed in the area through which the insects were distributed. The most spectacular success was obtained by the use of *Cactoblastis cactorum* for the control of "prickly pear", *Opuntia inermis* and *O. stricta* (3). After its introduction from South America, *Cactoblastis* practically cleared the whole of the enormous area which had previously been heavily infested with prickly pear, reducing this pest to negligible proportions. Almost equally spectacular results were obtained by the introduction of *Liothrips urichi* into Fiji to control *Clidemia hirta* (6). Some success has also been obtained in New Zealand by the use of *Apion ulicis* to attack gorse, *Ulex europaeus* (4). In some areas of New Zealand this weevil attacks almost 100 per cent. of the seeds produced. The introduction of *Teleonemia scrupulosa* into Queensland to attack *Lantana camara* has also been partially successful in that over large areas of the northern coastal region of Queensland the Tingitid bug almost completely prevents the flowering of lantana, and in smaller areas periodically completely defoliates it. It does not actually destroy lantana, but probably reduces its spread. Attempts to control ragwort, *Senecio jacobaea* (1), in New Zealand and Australia have not so far proved successful and this is also true of the nutgrass, *Cyperus rotundus*, in the Hawaiian Is. and Australia, but work on the latter two weeds has not been intensive. A good deal of attention has been given to the possibility of controlling Noogoora burr, *Xanthium pungens*, in Australia, and blackberry, *Rubus fruticosus*, in New Zealand, but both these projects have had to be abandoned because the more promising insects found proved to be dangerous to cultivated plants related to the weeds. Work on piri-piri (*Acaena sanguisorbae*) in New Zealand is continuing, and is of interest as the weed is a member of the Rosaceae.

This brief account indicates that the method of controlling weeds by means of their insect enemies is a very powerful one. Unfortunately it cannot be used for the control of all kinds of weeds, for many of these are closely related to plants of economic importance and the chance of finding insects that are both safe and effective when used

against such weeds appears remote. The method should be tried, however, against every weed to which it appears applicable, for it has proved by far the most economical method of weed control, and the successes already achieved justify the contention that it should become one of the main methods of weed control.

### Discussion

Sir Guy Marshall said he recollected that in the early years of the work failure to establish insects introduced to control *Hypericum* was attributed to attacks of native predators, an opinion which was supported by field evidence. This being so, why was it possible to establish the insects successfully later, he asked.

Dr. Nicholson replied, "I am glad Sir Guy has asked this question, for it gives me the opportunity to mention a point we have come to regard as of great importance. In our experience insects liberated in small numbers at single points, and in large numbers scattered over considerable areas, have generally failed to become established; whereas large concentrated liberations have been successful. We believe that this is due to the action of the general predators that exist wherever the insects are liberated. When the number of liberated insects is small the predators are numerous enough, and hungry enough, to consume them all; but when the numbers of liberated insects are very large many still remain after the predators are completely satiated. These survivors then multiply, and it is unlikely that the predators will multiply similarly, for the chance that the predators are adequately adapted to the habits and lifecycles of the introduced insects is small. In other words, the introduced insects provide an abundant surplus of food during certain seasons of the year, but at other seasons the predators have to depend on other insects for food, and their numbers will be mainly limited during the seasons when food is scarcest."

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## THE DEVELOPMENT OF AN ENTOMOLOGICAL INDUSTRY IN BRITAIN AND THE BRITISH COMMONWEALTH

By *W. E. Ripper*

For many years past it has been recognized by economic entomologists that advances in the practical application of entomological knowledge to the solution of pest problems in agriculture and public health has suffered from the fact that in many cases the carrying out of practical pest control operations has been left to the layman with no professional help or supervision.

The conditions of his employment have generally prohibited a Government Officer from undertaking the supervision of applied entomological operations except in the case of pests of exceptional national importance, such as locusts and Colorado beetles. Thus the application of most pest control measures has in the past been handled by farmers and the staffs of public health departments.

It will be recalled that the same position arose in other professions. Only a few years ago the management of important chemical industries, for example, gas works or sugar factories, was in the hands of engineers, and not until the coming of age of the chemical profession did the chemist take control of his own industry and relegate the engineer to his appropriate function in the organization of the factory.

It became obvious to some entomologists, notably Sir Guy Marshall, then Director of Imperial Institute of Entomology, that a similar change over was desirable in the entomological profession, but to bring this about an organization had to be created which would undertake entomological operations under contract with growers, to clear fields or orchards of agricultural or horticultural pests for a payment per acre in consideration of work done.

If applied entomology could be established as an applied science then an entomologist might be expected to plan, direct and execute an entomological operation more efficiently than a layman.

It was first thought that such a control organization should be set up by the Government, but a careful study of the question revealed so many legal and administrative difficulties that Sir Guy Marshall decided to launch the project as a private venture.

The result was the foundation of a private Company, Pest Control Limited, in 1939 which operated first in an experimental capacity applying methods of pest control which had hitherto been out of the reach of the farmer on account of their intricacy. The new venture, through its staff of entomological experts was able to advise the farmer on the economic aspects of his pest problems, and to answer the farmer's most important question, "will the value of the additional crop yield saved from pests be sufficient to cover the cost of the pest control treatment"? The population density of many agricultural pests is not sufficient every year to reduce seriously the crop yield, and unless the farmer has recourse to the judicious opinion of an entomologist on the relative population densities of the injurious and beneficial insects and their effect on the crop under prevailing weather conditions, a good deal of unnecessary expenditure may be incurred on insecticides and labour, which in the particular circumstances, unnecessary or ineffective.

Routine pest control operations applied without special regard to the degree of pest infestation of the crop are sometimes accepted as economic measures in horticulture but are seldom justifiable in the case of field crops.

It was soon found that, apart from decisions on the advisability and timing of treatment, the actual practice of many very intricate operations such as field fumigation with nicotine or the application of some of the new and more toxic synthetics, was much safer in the hands of specially trained entomologists. Qualified scientists and Medical Officers were also needed to supervise the welfare of the staff and to instal precautionary measures for protection of work staff engaged in pest control operations which involve large scale application of poisons, etc.

British farmers welcomed this new venture which provided a scientific contract spraying service, and the enterprise had the moral support of the British Ministry of Agriculture. As it was of prime importance that the application of these new methods should substantially increase the farmer's income, pest control treatments were only carried out when the entomological experts considered the degree of infestation by the pest such that the saving achieved by its eradication would warrant the cost.

In the early years of the new venture, these pest control operations were carried out only after consultation with the Government entomologists, who, in many cases first explored the bionomics of the pest infestation and proposed a method of control. Pest Control Limited then developed equipment, modified the formulation of the chemical if necessary and studied the critical population density at which control operations were likely to lead to increases of crop yield.

Perhaps I may liken this new entomological profession to the medical profession for, just as the doctors in hospitals and general practice apply the new cures discovered by the medical scientists in research institutes, perfecting the technique as they proceed, so did this new entomological organisation introduce on a large scale new methods which had been developed by research entomologists of the Government and Universities.

For example, backfly control on beet and beet seed in England was carried out for a number of years by the new organization in co-operation with a Government entomologist who acted as a scientific observer and supervisor, and whose advice was sought on question of policy. The Government entomologist (F. R. Petherbridge, M. A.), who had previously studied this pest for years, then saw the fruit of his research put to use on a large scale under the supervision of colleagues. In another instance, hopper burn on cotton in the Sudan was controlled by the application of a method of control worked out by co-operation of an entomologist of the Sudan Government (J. W. Cowland) who had explored the life history of the pest, and the entomologist of Pest Control Limited (C. J. Edwards) who brought toxicological and application knowledge to bear on the problem. In a very short time the hopper burn was successfully controlled on a truly large acreage, bringing a high increase in the yield of cotton.

The new pest control organization is operated in the following way: —

The main base is established in the United Kingdom and there the work is divided into

- 1) the actual pest control operations carried out by a contract spraying department,
- 2) the development and manufacture of machinery carried out by an engineering department working to the specification and works orders of entomologists,

- 3) the development and manufacture of insecticides carried out by a chemical department working to specifications and work orders of entomologists,
- 4) the development and operation of helicopter research carried out by an Aviation Department,
- 5) chemical research (under Dr G. S. Hartley) working on the development of new insecticides,
- 6) fundamental work on the human toxicology of insecticides on which health precautions, protection measures and the judicial care of the workmen can be carried out by a laboratory for human toxicology. The practical side of this work is carried out by an extensive medical organization, conducted by a Chief Medical Officer,
- 7) biological research carried out in a special department based in the United Kingdom, but staffed with qualified scientists who spend considerable periods of the year overseas.

The biological research work is concentrated on: —

- a) The discovery of methods to control pests which have hitherto been uncontrollable,
- b) the minimising of application costs,
- c) the investigation of new entomological principles which promise to lead to improvements in technique.

Towards the last mentioned objective we attempted to develop selective insecticides, that is insecticides which kill pests but do not harm the parasites and predators. The spraying of such chemicals thus supplements the biological control effected by the beneficial insects by a chemical control. In the last six years this work has been one of the major projects of our Research Department.

The development which we had achieved in the allied field of economic botany, namely the development of selective weedkillers encouraged us to work on selective chemicals for use in entomology, not only in an attempt to reduce the number of chemical applications and thereby the farmer's expenditure on pest control operations, but also to give new impetus to biological control and the importation of parasites which alone would be insufficient to hold a pest population in check, but whose work, supplemented by the effect of chemical control would be valuable. Thus, we hoped to widen the field of pests which could be controlled by parasites and predators.

The first fruit of this development work was field fumigation with nicotine, which enabled us to kill a high percentage of aphides without affecting predators and parasites. By careful timing it was possible to shift the biological equilibrium in such a way that the beneficial insect not only completed the eradication of the pest left over by the treatment but for a number of weeks kept the field clear from newly arriving pest migrants. The field fumigation method was used on a large scale for six years but it is now likely that it will be superseded by a new method of selective insecticide action, namely the application of systemic insecticides.

Work carried out under our Biological Research Manager, Dr R. M. Greenslade, by a team of our entomologists led to the discovery that the systemic insecticide bis (bis dimethyl aminephosphonous) anhydride (Pestox III) will render certain plants, such as hops, brussels sprouts and peas, toxic to aphids without affecting parasites and predators.

Control operation using selective insecticides are timed in accordance with an appreciation of the biological complex and require a standard of entomological knowledge and judicious timing which could never be expected of a layman.

Reverting to the organization of the contract spraying work we operate in England from thirteen branches, which are situated in all the intensively cultivated areas of the country. Each Branch is a headquarters for contract spraying operations and advisory service, where the farmer can find scientific advice and, if he desires, places his order for spraying. Each Branch is equipped with maintenance shops for repairs to spraying equipment, chemical storage, laboratories, and offices.

In an attempt to reduce the cost of pest control operations we have tried to arrange a year round employment of the spraying machines and auxiliary plant, and, most important of all, of our entomologists. Towards this end we have established a number of overseas companies which allow us to follow the season of greatest insect activity as it moves from England southwards through the length of Africa.

Operations are conducted in the Sudan, Kenya, Northern and Southern Rhodesia, and the Union of South Africa with bases in all these countries.

This hemispherical set-up is very valuable insofar as it allows us to spread development costs over big acreages, give added interest to the work of the entomologists who migrate between the various theatres of operation and enable us to evolve a cycle of operations for the spraying helicopter. We have done a good deal of development work on this new type of spraying machine, using the Sikorski S.51 because of its relatively high load carrying capacity.

Our Aviation Department works in very close co-operation with the other contract spraying organizations and entomologists are permanently attached to this section. New modifications of spray chemicals for aerial application are being evolved, chiefly making use of concentrated sprays, and experiments are being made with systemic insecticides. In the development of aerial spraying it was found a great advantage to have chemists, aeronautical engineers and entomologists working together as a team carrying out an entomological policy.

On the Board of the organization in England, as well as on all the Boards of the overseas companies, entomologists are well represented.

From the outset, careful attention has been devoted to the problem of application of insecticides. In the past many good insecticides and entomological methods were impractical because the existing equipment for the application was inadequate. To remedy this position, we established an engineering works to design and construct large output spraying machines specially adapted to the contractors' requirements. The effort included also the development of new tractors, such as the high clearance tractor, and excessively narrow tractors for special purposes. New designs for these special purpose machines were essential because previously agricultural engineers had designed only pest control machinery adapted for the farmer's own use. In order that we might be in a position to offer an entomologist's supervision we had to reduce the cost of our spraying operations by developing contractors' tools more robust, larger and capable of use the year round. A comparison of the variation in the size of civil engineering plant designed for the use of the private owner and the civil engineering contractors' plant will give an appreciation of the problem with which we were faced.

In addition to this mechanical scaling up in size a modern spraying machine has to be considered as a chemical plant, and principles of chemical engineering are of prime importance in providing means to avoid corrosion and filtration troubles. Many

spraying machines in the past have suffered from the fact that they were built by agricultural engineers who had not the advice of chemical engineers or entomologists.

Some difficulty was experienced in the early days of this entomological industry in interesting the chemical industry in selective chemicals and it was decided that the course followed in the engineering field must be repeated in the chemical field. We therefore established our own chemical works where chemicals could be manufactured to the entomologist's specifications.

Under British conditions control of insect pests alone did not afford sufficient work of a remunerative nature to support the whole venture. It therefore had to be combined with spraying operations for weed control and the prevention of plant diseases.

Looking back on the nine years' work we may say that entomologists by organizing themselves in a scientific industry were able to exert a greater influence on the shaping of their own tools and methods by inducing engineers and chemists to work to entomological specifications.

Progress in pest control methods has therefore been rapid and I am sure that similar organizations will be set up in other countries to ensure that entomological methods are practised scientifically and on a wider scale, thus increasing the importance and the prestige which entomologists enjoy in the community.

#### Appendix

Record of Ten Years' Progress made in the Practice of Applied Biology in the Agriculture of England and certain Parts of the Commonwealth by Pest Control Ltd.

- 1939. First commercial control of Black Fly (*Aphis fabae*) on sugar beet.  
Introduction of Cabbage Aphis (*Brevicoryne brassicae*) control by gassing over small acreage.  
First 100 per cent kill of Strawberry Aphis (*Capitophorus fragariae*).  
First commercial control of Green Fly on peas (*Macrosiphum pisi*).
- 1940. First commercial control of Black Fly on sugar beet seed.  
First commercial control of Pea and Bean Weevil on peas.  
Large scale application of gassing against *Brevicoryne brassicae*, being the first application of "selective" insecticides, enlisting the help of pest-killing insects over a large acreage.
- 1941. First commercial control of Pollen Beetle on swede seed on considerable acreage in Lincolnshire.  
First acid weeding of onions on a commercial scale.
- 1942. First use of "selective" synthetic weed-killer (D.N.C.) on corn over several thousand acres (DENOC).  
Introduction of concentrated acid spraying for burning off potato haulm for blight prevention.  
First commercial control of Carrot Fly on carrots (*Psila rosae*).  
First extensive campaign against Black Fly on sugar beet, and sugar beet seed all over England.  
First control of Green Fly on potatoes by nicotine fumigation (*Myzus persicae* and *Macrosiphum solanifoli*).
- 1943. First control of Carrot Fly on celery on considerable acreage.  
Introduction of automatic oscillating orchard sprayer over large orchard acreage.  
Introduction of concentrated acid spraying on corn and onions.



1944. First commercial control of Pea and Bean Weevil (*Bruchus rufimanus*) over a large acreage.
1945. First commercial control of Swede Weevil (*Centorrhynchus assimilis*) and swede seed Midge (*Dasynura brassicae*) on Brassica seed on large acreage.  
Introduction of a selective acaricide, containing DNCHP (Dynone), for control of Red Spider on hops and orchards.  
Introduction of oil-fixed D.N.C. winter wash.  
Introduction of plant hormone weed-killers containing M.C.P.A.  
First large scale spraying of cotton in the Sudan (incidentally the first large scale application of chemical control to agriculture in tropical Africa).  
First spraying trials by helicopter.
1946. First weed control using a combination of D.N.C. and plant hormone.  
First commercial control of Pea Moth.  
First public demonstration of helicopter spraying.  
First Tobacco spraying in Rhodesia for the control of *Alternaria longipes* and *Cercospora nicotianae*.  
First Celery spraying using high clearance tractor and high clearance spraying machine.  
First automatic Fruit-tree spraying in South Africa.  
First automatic Citrus spraying in South Rhodesia.
1947. Large scale control of Aphids and Red Spider with H.E.T.P.  
First large scale plant hormone spraying in South Africa.  
First Large scale application of D.D.T. with Fungicide for control of Green Fly on Potatoes.  
First large scale control of weeds in Linseed by plant hormones (M.C.P.A.).  
First Fruit spraying by high clearance tractor.  
First large scale application of D.D. for control of *Heterodera marioni* in South Rhodesia.
1948. First commercial application of systematic insecticide Pestox III.  
First commercial application of D.N.B.P. (Sevttox) for control of weeds in Peas and Lucerne.  
First successful experiment to prevent yellow virus on Beet by application of Pestox III.  
Inauguration of the Spraycopter service and  
First Commercial Helicopter spraying of Potatoes, Celery, Peas and Linseed.
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## SECTION I

### THE NEED FOR BIOLOGICAL INVESTIGATIONS IN THE SPECIFIC DETERMINATION OF GALL MIDGES

By H. F. Barnes

A glance or more often a detailed examination with the aid of a microscope will be sufficient to determine the particular species of a dead insect specimen belonging to many groups of insects. But both these methods are often completely inadequate when one is dealing with Gall Midges (*Cecidomyiidae*) and with certain other families of insects, such as the Aphids.

The object of this paper is to emphasise the necessity for biological investigations in order to obtain correct specific determination of gall midges. This is of great importance when dealing with gall midges attacking crops. The method adopted is to give examples of problems concerning the identity of certain gall midges of economic importance that have been referred to the writer during recent years and to give a brief survey of some of the investigations either actually in progress or needing immediate attention. The conclusions reached are that such biological investigations involve the setting up of museums of living insects and plants, that such investigations are necessarily of a long term nature and that those carrying them out should be biologists in the widest sense of the word, i.e. able to use all the aid that allied sciences, such as for example, ecology, biometry, plant breeding and biochemistry, are already offering or at least be stationed in close proximity to other workers in these fields. Further, these biological investigations must go on hand in hand with the indispensable work carried out on dead insects by museum specialists, more of whom could then be diverted from mere routine identification of species to their proper function, the study of the relationships of genera, families and so on.

#### *Cereal Gall Midges*

The two Wheat Blossom midges (*Contarinia tritici* Kirby and *Sitodiplosis mosellana* Géhin) have been under continuous study on the permanent wheat at Rothamsted Experimental Station for the past 22 years. These gall midges usually emerge just when the wheat ears are bursting their sheaths. In 1947, there was a remarkable spell of hot weather at the end of May and the midges started emerging fully a fortnight before the wheat ears started emerging. They were to be seen at the top of wheat seeking the ears in vain. Observations showed that lemon-coloured *Contarinia* midges were egg-laying during these evenings on Slender Foxail (*Alopecurus myosuroides*) and on Couch grass (*Agropyron repens*) both in the permanent wheat field at Harpenden and in a field at Bedford which in 1946 was under wheat but in 1947 under oats. The question immediately arose as to whether these midges were in fact *Contarinia tritici* attacking a weed grass. Later the wheat at Harpenden came into ear and some of the *C. tritici* emerging later oviposited successfully on it. Owing to the morphological similarity of the *Contarinia* species which are known to live on wild and cultivated Gramineous plants it was impossible to be certain that the midges egg-

laying on the *Alopecurus* and the *Agropyron* were *C. tritici*, especially bearing in mind that *Contarinia merceri*, the *Contarinia* of *Alopecurus*, was known to live in this particular field at Harpenden. The only course to be adopted, in the absence of a museum of living *Contarinia* species of grasses, was to breed midges from the larvae subsequently found in the *Alopecurus* and *Agropyron* together with genuine *C. tritici* from wheat and then in 1948 attempt inter-mating and breeding experiments of the midges from *Alopecurus* and *Agropyron* on Wheat and vice versa. This has been done. The conclusion has now been reached that the midge living on the *Agropyron* was the genuine *Contarinia tritici*, whereas the one on the *Alopecurus* was not but in fact *Contarinia merceri* Barnes, originally described from Meadow Foxtail (*Alopecurus pratensis*).

Another example this time from Italy. Dr. Domenico Roberti has been studying the *Mayetiola* of Barley. This should be *M. mimeuri* Mesnil, but an examination revealed an overlapping of characters with the Hessian Fly (*M. destructor* Say) of Wheat. Quite justifiably Dr. Roberti was puzzled as to the species with which he was dealing. I made a comparison of Dr. Roberti's material with specimens of *M. destructor* from wheat in several countries and of *M. avenae* Marchal from oats (*Avena sativa*) in Italy. The conclusion had to be reached that slides of male and female midges are not sufficient to distinguish the three species, largely because of variation. In this case however examination of the larval breastbone or sternal spatula serves to distinguish *M. avenae* from the other two species. But more biological experimentation similar to that done so well by Paul Marchal is needed to separate these *Mayetiola* species known from wheat, barley and oats especially as several closely allied species have been described, usually rather inadequately, from wild grasses. The importance of knowing whether these wild grasses can serve as reservoirs for the cereal attacking species is no less important than knowing whether the barley alone or the barley and wheat will be liable to attack. Similarly studies of the range of variation of possible specific characters are needed, always remembering that if a character is minute and difficult to see in preparations, such that with care any entomologist can prepare, its value is not very great to the non-specialist entomologist.

### Cabbage Midges

Kieffer in 1886 described *Contarinia nasturtii* from midges whose larvae caused the flowers of Marsh Watercress (*Nasturtium palustre* (Leyss.) DC. now known as *Rorippa islandica* (Oeder) Borbas) to become swollen and remain closed. Later in 1893 he recorded it from the blossom of Rape (*Brassica napus*). When Taylor about 1910 discovered the "cabbage top", "many-necked" and "crumpled leaf" condition of Swedes (*B. rutabaga*) in England, Kieffer confirmed that the species was again *C. nasturtii*. De Meijere of Holland, however, considered that the *Contarinia* which caused blindness and distortion of the hearts in Savoy Cabbages was a distinct species and described it as *C. torquens* in 1906. This is the damage known as "Draaihartigheid", "Krauselkrankheit" and "Drehherzigkrankheit". Later still in 1917 Rübsaamen in Germany described *C. geisenheyneri* stating that its larvae lived in the blossom of various species of *Brassica*.

The question arises does *C. nasturtii* cause both blossom and leaf damage; in other words is the midge that Taylor found causing "cabbage top" of swedes identical with *C. nasturtii* of Watercress blossom? It has been thought that *C. torquens* is synonymous with *C. nasturtii*. This is probably true if one means the *C. nasturtii* as known in

England from the leaf damage. Further it has been suggested that *C. geisenheyneri* is synonymous with *C. nasturtii*? It seems possible that *C. geisenheyneri* is synonymous with the *C. nasturtii* of Watercress blossom. But the question of its synonymy with the *C. nasturtii* of "cabbage top" in England or with *C. torquens* of "Draaihartigheid" in Holland is quite different. On the other hand Dr. Prosper Bovien in Denmark in 1938 wrote saying that he had placed several hundreds of *C. nasturtii* from "crumpled leaf" on swedes with flowering swedes and found their G. 1 produced exactly the same flower damage that is generally ascribed to *C. geisenheyneri*. On the other hand Dr. S. Leefmans of Holland is convinced that *C. torquens* of Draaihartigheid damage is not the same midge as *C. geisenheyneri* of Brassica flower damage.

It is obvious that here again there is an urgent need for exact biological investigations accompanied by detailed studies of the variation of morphological characters. In England attempts are now being made to elucidate this problem by endeavouring to find out whether the midge we know as *C. nasturtii* will in fact live in *Brassica* flowers and more important if it will live on Watercress flowers. This latter entails growing the various species of *Nasturtium*, *Rorippa* and *Brassica* varieties, having them in a suitable stage for oviposition by the midges at the same time as our midges from Brassica leaves are ready to oviposit.

In addition, this year Dr. W. M. Docters van Leeuwen very kindly sent me galls containing living larvae of the true *Contarinia nasturtii* on *Rorippa amphibia* Besser from Holland. By great good fortune also I have been able to find identical galls on the same *Rorippa* species at Bedford this summer. Consequently I have been able to rear both Dutch and English midges and from successful inter-mating experiments it is now clear that the same species occurs on this plant in both countries. This means that the true *Contarinia nasturtii* of Kieffer undoubtedly occurs in England as well as on the continent. Experiments have been set up to see whether these midges from *Rorippa amphibia* flowers will cause the well known leaf damage on *Brassica*. But it is too early yet to give the results of these experiments.

### Fruit Midges

The Red Bud Borer, *Thomasiniana oculiperda* Rübsaamen, was described in 1893; its larvae live in grafts on rose and fruit trees. The Raspberry Cane Midge, *Thomasiniana theobaldi* Barnes, was described in 1927; its larvae live under the rind of Raspberry. The Hawthorn Stem Midge, *Thomasiniana crataegi* Barnes, was described in 1939; its larvae feed under the rind of Hawthorn twigs and branches. In addition H. Pape found larvae of a *Thomasiniana* species under the rind of *Ribes alpinum* at Mülheim in 1938 and reared midges from them. These four midges are indistinguishable morphologically but from the growers' point of view are different since they appear to be restricted to different crop plants. Their similarity extends to many points in their bionomics. Thus they all live wounds or scared tissues of the plants. Investigations on the host plant range of *T. theobaldi* have been done in the past by Mr. R. S. Pitcher at East Malling Research Station in Kent. In this group of midges *T. theobaldi* is perhaps of greatest importance because of its association with Cane Blight and other fungus diseases of the raspberry stem, although the *T. oculiperda* has caused great losses to rose growers and what may be the same species has caused losses to those grafting apples.

Two other groups of fruit midges which need serious investigations are those comprising three midges which attack the flowers of Gooseberry, Black Currant and Red Currant and three midges which damage the terminal growing leaves of the same three *Ribes*, together in each case with one which attacks the same parts of Blackberry (*Rubus*). The flower midges are *Contarinia ribis* de Meijere on Gooseberry in Holland, *Dasyneura ribis* Barnes on Black Currant in Finland, an unidentified gall midge on Red Currant in Germany and *Contarinia rubicola* Rübsaamen on Blackberry. The leaf midges are *Dasyneura tetensi* Rübsaamen, a serious pest of Black Currant in England and one which is spreading throughout the country, *Dasyneura ribicola* Kieffer on Gooseberry, *Asphondylia ribesii* Meigen on Red Currant and *Dasyneura plicatrix* H. Loew on Blackberry. The problem here may be just as much concerned with the biochemistry or physiology of the plant sap as with the specific identity of the midges.

#### Other Gall Midges

The writer a few years ago, in a study of the gall midges of Cocksfoot grass (*Dactylis glomerata*), suggested a change over had taken place from Foxtail (*Alopecurus pratensis*) to Cocksfoot by one of the midges, *Stenodiplosis geniculati* Reuter, accompanied by a slight morphological difference in New Zealand. It was found that the midge in question occurred on both grasses in Great Britain but there was then no visible morphological differences between the midges reared from the two grasses. It would be interesting to know whether the same difference will appear in time in Great Britain as clearly exists already in New Zealand. It would also be of great importance to know how often such changes in host plant occur. To find this out would entail once more a museum of living plants and insects.

Coming to the zoophagous gall midges, it was suggested some years ago that gall midges whose larvae were predaceous on coccids might be used in an attempt to control biologically coccids. It was thought that gall midges found in the Far East could be usefully transported to Africa for this purpose. But the identification of the species found could not be determined. A detailed study of their bionomics especially the prey range is an essential preliminary to their specific identity and use in biological control experiments.

The same problems have arisen recently in Palestine. Here it is a question of the prey range of certain aphid-eating gall midges.

As a last example, the gall midges whose larvae feed on fungus, rust and mildew may be mentioned. Does a species of midges have a large range of food or is one midge restricted to one food? It is usually impossible to separate satisfactorily the midges on morphological characters.

#### Conclusions

There seems to be a good case for biological investigations to aid in the specific determination of gall midges. It may of course be argued that one has not looked deep enough for distinguishing morphological characters, but while admitting to finding differences when examining small numbers of individuals, one cannot help being impressed by the great variation exhibited when examining large numbers. In addition it must be emphasised that the use of characters so minute and difficult to see that they are only occasionally readily visible in mounts made even by experts is not really satisfactory especially to non-specialist entomologists such as advisory or extension workers.

It seems that in order to carry out such biological investigations what is needed are gardens or museums, call them what you will, of living insects and plants. The old herb gardens were places where one could study alive all the herbs. Why could there not be places or collections of living gall midges and plants so that one would be able to carry on inter-mating experiments alongside host plant or prey range experiments whenever necessary. It takes considerable time to get both the midges and the plants available and then it may be several seasons before one has both the midges and plants available at the same time.

Such investigations should be undertaken only by broadminded biologists who will be ready and qualified to bring in other sciences to their aid. Except a man be willing to use ecological, biometric, statistical, plant breeding and even biochemical methods, the investigations will not have much chance of being complete. It is unusual to find such workers. As an alternative such biological systematists, as I like to consider them, could work at experimental stations where the staff includes scientists of all branches who would be willing to help and stimulate them. Moreover such investigators should be within easy access of museums where specialists' great skill in "spotting" characters of use in systematics would be available. Close co-operation between the old and new systematists is most essential. Furthermore such investigators should not be unduly hurried and harried to get results: the investigator should be left and trusted to seize his opportunities when they arise.

I must confess, in conclusion, that I personally have been exceptionally fortunate in being appointed to the staff of Rothamsted Experimental Station where such investigations of a long-term nature have been encouraged and I would like to take this opportunity of putting on record my deep gratitude to the Lawes Agricultural Trust, the two Directors under whom I have worked, Sir John Russell and Dr. W. G. Ogg, the two heads of the Entomology department, Dr. A. D. Imms and Dr. C. B. Williams, and others who have given me these great facilities. But the setting up of units or departments of biological systematics is worthy of consideration by Departments of Agriculture.

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## DAS GENUS PANOPLOSCELIS SCUDDER (Orthopt.- Pseudophyllinae).

Von M. Beier

Die Gattung *Panoploscelis* Scudder (1869), die erst von Dohrn (1888) kenntlich beschrieben wurde, umfasst sehr robuste, stark bedornte, kurzflügelige und durchwegs braun gefärbte Pseudophyllinen aus dem Amazonas-Gebiet, die dadurch besonders merkwürdig sind, dass das Weibchen ein wohlausgebildetes und sehr auffälliges falsches Tympanum besitzt, welches als hyaline Membran zwischen den beiden Medialis-Ästen der Elytren ausgespannt ist und daher keine dem männlichen Schrifforgan homologe Bildung, sondern eine solche sui generis darstellt. Inwieweit dieses Organ wirklich zur Lauterzeugung benützt wird, ist noch unbekannt, wie überhaupt über die Lebensweise dieser vermutlich nächtlichen, tagsüber wahrscheinlich in Wurzelhöhlungen des Urwaldes verborgenen Tiere noch keine Angaben vorliegen. Trotz der Auffälligkeit der hierher gehörigen Formen ist auch die Artsystematik der Gattung bisher noch nicht bearbeitet worden, was zum Teil an der Seltenheit des Materiales liegen mag. So wurden alle bisher bekannt gewordenen Stücke — es handelt sich insgesamt um sechs Exemplare — sämtlich als *P. armata* Scudder, die einzige beschriebene Art, gedeutet (die von Walker ebenfalls unter *Panoploscelis* beschriebenen Arten *tuberculata* und *tuberosa* gehören in das Genus *Choeroparnops* Dohrn = *Echinacris* Pictet). Im Zuge einer Revision der gesamten Pseudophyllinen, deren Fertigstellung leider durch den Krieg verzögert wurde, lag mir ein verhältnismässig reiches, aus 7 Exemplaren bestehendes Material dieser seltenen Gattung vor, in dem sich nicht weniger als 4 sehr gut unterscheidbare Arten feststellen liessen. Ich mache diese Arten nun im Rahmen einer Revision der Gattung bekannt.

### *Panoploscelis* Scudder.

*Panoploscelis*, Scudder, Proc. Boston Soc. nat. Hist., XII, 1869, p. 333.

*Panoploscelis*, Dohrn, Stett. ent. Zeitschr., 49, 1888, p. 355, 356.

*Panoploscelis*, Brunner v. W., Monogr. Pseudophyll., 1895, p. 196.

*Panoploscelis*, Bruner, Ann. Carnegie Mus., IX, 1915, p. 341.

Grosse, robuste, braun gefärbte Tiere. Kopf gross, rund. Fastigium verticis mit dornförmiger, die Ränder der Fühlergruben überragender Spitze. Vertex, Genae und Frons mehr oder weniger grob runzelig punktiert, die Frons flach, seitlich leistenförmig begrenzt, das Fastigium frontis dornförmig oder stumpf tuberkelförmig. Scapus der Fühler mit kurzem, stumpfem Enddorn und mitunter auch mit einem kräftigen Dorn an der Innen- bzw. Ventralseite. Pronotum mehr oder weniger grob runzelig granuliert, mit 2 scharf eingeschnittenen Querfurchen, die Scheibe verrundet in die Seitenlappen übergehend, der Vorderrand mit mehr oder weniger deutlichem Tuberkelchen, die Metazone stärker oder schwächer ansteigend, der Hinterrand gerade abgestutzt oder flach verrundet. Elytren in beiden Geschlechtern nicht oder nur wenig länger als das Pronotum, beim Männchen Subcosta und Radius einander stark genähert, die Medialis erhaben, gegen die Spitze zu jedoch plötzlich verflacht, das Schriffeld gut entwickelt und gross; beim Weibchen zwischen den beiden Medialis-Ästen, von denen der erste mitunter besonders stark entwickelt ist, ein grosses falsches Tympanum mit mehr oder weniger glasiger Membran eingeschlossen, die Membran von 4 bis 5 einreihig

und scharf granulierten Queradern durchzogen, die mitunter durch feinere Adern untereinander verbunden sind. Alae stark verkürzt. Prosternum mit 2 Dornen. Meso- und Metasternum ziemlich schmal, bedornt, die Metasternalgrübchen vereint. Sämtliche Femora ventral, die Vorder- und Hinterfemora meist auch dorsal kräftig bedornt. Genicularloben mit Ausnahme der hinteren Loben der Vorderfemora und der vorderen Loben der Hinterfemora mit Enddorn, dieser an den Vorderfemora besonders kräftig. Sämtliche Tibien ventral und dorsal sehr kräftig bedornt, die Gehöröffnungen der Vordertibien bedeckt, schmal. Abdomen gross, dorsal mit Andeutung eines Mittelkiesels. Endtergit des Männchens abgestutzt, in der Mitte depress. Supraanalplatte dreieckig oder terminal abgerundet, mit leistenförmig verdickten Seitenrändern. Männliche Cerci kurz, dick, zapfenförmig, medio-ventral mit einem kurzen, einwärts gerichteten Dorn. Männliche Subgenitalplatte ziemlich kurz, terminal nicht tief ausgeschnitten, die Styli mässig lang, stäbchenförmig. Ovipositor lang, fast gerade. Weibliche Subgenitalplatte terminal mit kleinem, U-förmigen Ausschnitt, die Endloben jederseits von diesem mehr oder weniger dorn- oder krallenförmig verlängert.

Verbreitung: Oberes Amazonas-Gebiet (NW-Brasilien, Guayana, N-Peru, Ecuador).

Genustypus: *Panoploscelis armata* Scudder.

1. Vorder- und Hinterfemora dorsal mit einer Dornenreihe; Vorder- und Mittelfemora an beiden Ventralkanten bedornt; Fastigium frontis dornförmig, spitzig; Vorderrand des falschen Tympanums beim Weibchen nicht auffällig verstärkt 2
- Vorder- und Hinterfemora dorsal vollkommen unbewehrt; Vorderfemora an der äusseren Ventralkante nur distal mit einigen Dornen; Fastigium frontis stumpf; Vorderrand des falschen Tympanums beim Weibchen extrem stark erhaben ..... *P. specularis* n. sp.
2. Metazone des Pronotum nicht oder kaum länger als die Mesozone, hinten nur ganz wenig und nicht lamellär erhoben ..... 3
- Metazone des Pronotum etwa  $1\frac{1}{2}$ mal so lang wie die Mesozone, hinten sehr stark lamellär erhoben ..... *P. armata* Scudder
3. Supraanalplatte mit scharfem Terminalwinkel; Ovipositor kräftig und breit, etwa 5mal so lang wie breit, lanzettlich ..... *P. scudderi* n. sp.
- Supraanalplatte terminal vollkommen verrundet; Ovipositor schlank, etwa 6.5mal so lang wie breit, distalwärts ganz allmählich verjüngt ..... *P. angusticauda* n. sp.

*Panoploscelis scudderi* n. sp.

*Panoploscelis armata*, Walker, Cat. Brit. Mus., III, 1870, p. 435 ♂ (nec *P. a.* Scudder).

♂♀ Verhältnismässig lichtbraun. Fastigium verticis mit dornförmiger, die Ränder der Fühlergruben überragender Spitze. Fastigium frontis dornförmig, spitzig. Scapus der Fühler ausser dem stumpfen Endzähnnchen mit abstehendem Distaldorn auf der Ventralseite. Pronotum wabenartig gerunzelt, die Metazone so lang wie die Mesozone, hinten nur wenig aufgerichtet, der Hinterrand fast gerade abgestutzt, in der Mitte wenigstens beim Weibchen eingedellt, der Vorderrand mit kleinem Mediantuberkelchen. Elytren des Weibchens deutlich länger als das Pronotum(♂?), im Distalteil regelmässig oval und ziemlich dicht netzmaschig geadert, das Costalfeld mässig breit, das falsche Tympanum verhältnismässig schmal, mit leicht konkavem Lateralrand, die es dort begrenzende Medialis kaum verstärkt, die Membran mit 5 bis 6 gezähnelten Queradern. Alae in der Ruhe so lang wie die Elytren. Metasternalgrube quadratisch. Vorderfemora dorsal mit einer, ventral ebenso wie die Mittelfemora mit 2 vollständigen



Dornenreihen; Hinterfemora dorsal mit einer Dornenreihe. Der äussere Ventralrand der Hintertibien mit vollständiger, der innere nur distal mit einer kurzen Dornenreihe. Supraanalplatte distal dreieckig zulaufend. Männliche Cerci zapfenförmig, in der Mitte ventro-medial mit einem einwärts gerichteten Dorn, gelb. Ovipositor kräftig und breit, etwa 5mal so lang wie breit. Männliche Subgenitalplatte kurz, so lang wie an der Basis breit, terminal mit dreieckigem Ausschnitt, die Styli ziemlich dick, stäbchenförmig. (Weibliche Subgenitalplatte zerstört).

Körper L. ♂ (Larve) 48 mm, ♀ 64 mm; Pronotum L. ♂ 12 mm, ♀ 14 mm, Metazone L. ♂ 4 mm, ♀ 4.5 mm, Elytren L. ♂ ?, ♀ 18 mm, Costalfeld bis M.B. ♀ 7 mm, Tympanum ♀ L. 10 mm, B. 4.5 mm, Vorderfemora ♂ 19 mm, ♀ 25 mm, Vordertibien ♂ 20 mm, ♀ 28 mm, Hinterfemora ♂ 28 mm, ♀ 38 mm, Hintertibien ♂ 30 mm, ♀ 44 mm, Ovipositor L. 34 mm, B. 6.5 mm, ♂ Subgenitalis L. 4 mm, Styli 2.5 mm.

Type: 1 ♂ Larve (letztes Stadium), Rio Branco, N.-Brasilien, Staudinger, Coll. Br. v. W. Nr. 26875 (Museum Wien).

Allotype: 1 ♀, Britih Guayana (Museum Stettin Nr. 382).

Sonstiges Vorkommen: Egas, Amazonas-Gebiet, NW-Brasilien.

*Panoploscelis angusticauda* n. sp.

*Panoploscelis armata*, Brunner v. W., Monogr. Pseudophyll., 1895, p. 197 (partim) ♀, Taf. VIII, Fig. 87.

♀. Braun. Fastigium verticis die Ränder der Fühlergruben überragend. Fastigium frontis dornförmig, spitzig. Scapus der Fühler ausser dem stumpfen Enddorn noch mit einem abstehenden Dorn distal auf der Ventralseite. Pronotum ziemlich dicht gerunzelt, der Vorderrand mit dornförmigem Medianzähnen, die Mesozone jederseits mit einer glatten Schrägfläche, die Metazone so lang wie die Mesozone, hinten nur wenig aufgerichtet, der Hinterrand gerade abgestutzt und in der Mitte eingedellt. Elytren kaum länger als das Pronotum, distal sehr schwach lappenförmig vorgezogen und retikuliert, das Costalfeld mässig breit, das falsche Tympanum des Weibchens ziemlich klein, rauchig getrübt, mit 3 bis 4 gezähnelten Queradern, lateral konvex begrenzt, die es dort begrenzende Medialis nur als etwas stärkere Ader entwickelt. Alae in der Ruhe so lang wie die Elytren. Metasternalgrüben quadratisch. Vorder- und Mittelfemora ventral mit 2 vollständigen Dornenreihen, Vorder- und Hinterfemora dorsal mit einer Dornenreihe. Hintertibien am inneren Ventralrand nur distal mit einigen wenigen Dornen, der äussere Ventralrand mit vollständiger Dornenreihe. Supraanalplatte distal vollkommen verrundet. Ovipositor schlank, gerade, allmählich verschmälert, viel schlanker als bei den anderen Arten, etwa 6.5mal so lang wie breit, vor dem Ende ohne Schrägfallen. Weibliche Subgenitalplatte quer, terminal U-förmig ausgeschnitten, mit kleinen, dornförmigen Endloben, die konvergierenden Ränder seitlich von den Endloben etwas lappenförmig vorgezogen.

Körper L. ♀ 60 mm; Pronotum L. 14 mm, Metazone 5 mm, Elytren L. 15 mm, Costalfeld bis M.B. 6.5 mm, Tympanum ♀ L. 9 mm, B. 4.5 mm, Vorderfemora 24 mm, Vordertibien 27 mm, Hinterfemora 36 mm, Hintertibien 41 mm, Ovipositor L. 32 mm, B. 4.7 mm.

Type: 1 ♀, Rio Negro, NW.-Brasilien, Natterer leg. (Museum Wien).

*Panoploscelis armata* Scudder.

*Panoploscelis armata*, Scudder, Proc. Boston Soc. nat. Hist., XII, 1869, p. 334.

*Panoploscelis armata*, Dohrn, Stett. ent. Zeitschr., 49, 1888, p. 358 (partim), Taf. II, Fig. 1.

*Panoploscelis armata*, Brunner v. W., Monogr. Pseudophyll., 1895, p. 197 (partim).

♀♂. Braun. Scapus der Fühler ausser dem Endzähnnchen noch mit einem spitzen, abstehenden Dorn distal auf der Ventralseite. Pronotum grob runzelig granuliert, die Prozone nicht, die Mesozone kaum gebuckelt, der Vorderrand mit dornförmigem Medianzähnnchen, die Metazone deutlich länger als die Mesozone, im hinteren Teil stark lamellär aufgerichtet, der Hinterrand flach verrundet. Elytren etwas kürzer als das Pronotum, der Endteil beim Männchen stark, beim Weibchen schwächer lappenförmig abgesetzt, das Costalfeld breit; Schrillorgan des Männchens den Hinterrand weit überragend, mit sehr kräftiger Schrillader, beide Tympana hyalin; falsches Tympanum des Weibchens oval, hyalin, mit 3 bis 4 gezähnelten Queradern, die Medialis nur schwach verdickt, kaum leistenförmig; Endteil der Elytren ziemlich grob retikuliert. Alae stark rudimentär, sehr klein. Metasternalgrube tief, kaum längsgestellt. Vorder- und Mittelfemora ventral beiderseits mit vollständiger Dornenreihe. Vorder- und Hinterfemora dorsal mit einer Dornenreihe. Innere Ventralrand der Hintertibien nur distal mit einigen Dornen. Supraanalplatte dreieckig zulaufend, die Ränder etwas exkaviert und verdickt. Ovipositor kräftig, breit, etwa 5mal so lang wie breit, vor dem Ende mit Schrägfältchen. Männliche Cerci kräftig, stumpf kegelförmig, gelb, in der Mitte mit einwärts gerichtetem Dorn. Männliche Subgenitalplatte kurz, breit, gelb, terminal sehr flach ausgeschnitten, die Styli ziemlich lang, stäbchenförmig. Weibliche Subgenitalplatte breit, distalwärts wenig verjüngt, mit ziemlich breitem Endausschnitt, die Endloben dornförmig, seitlich gut abgesetzt.

Körper L. ♂♀ 63 mm; Pronotum L. ♂ 17.5 mm, ♀ 16 mm, Metazone L. ♂ 7.5 mm, ♀ 6 mm, Elytren L. ♂ 14—14.5 mm, ♀ 15 mm, Costalfeld bis M.B. ♂ 4 mm, ♀ 7 mm, Schrillfeld ♂ L. 9 mm, Schrillader 5.5 mm, Tympanum ♀ L. 9 mm, B. 5 mm, Vorderfemora ♂ 29 mm, ♀ 28 mm, Vordertibien ♂ 31—32 mm, ♀ 32 mm, Hinterfemora ♂ 42 mm, ♀ 41 mm, Hintertibien ♂ 48—50 mm, ♀ 47 mm, Ovipositor L. 34 mm, B. 6.5 mm, ♂ Subgenitalplatte L. 7.5 mm, B. 6.5 mm, Styli 3.5 mm.

Diese Art wurde von Iquitos, Amazonas, NW.-Brasilien, beschrieben. Mir lagen 1 ♂ und 1 ♀ vom Marañon, N.-Peru, aus dem Museum Stettin vor. Die Fundortangabe „Napo“ von Scudder ist sicher falsch. Alle übrigen Fundortangaben beziehen sich auf andere Arten.

*Panoploscelis specularis* n. sp.

♀. Habituell der *armata* sehr ähnlich. Matt pechbraun. Fastigium frontis tuberkelförmig, stumpf. Scapus der Fühler mit stumpfen Endzahn, auf der Ventralseite nur mit einem kleinen Distaltuberkelchen, ohne Dorn. Pronotum grob runzelig granuliert, mit ziemlich stark gebuckelter Pro- und Mesozone, sehr tief eingeschnittener hinterer Querrfurche und wie bei *armata* ziemlich langer Metazone, diese deutlich länger als die Mesozone, hinten schräg lamellär aufgerichtet, mit noch stärker gebogenem Hinterrand als bei *armata*; Vorderrand ohne Zähnnchen. Elytren so lang wie das Pronotum, das falsche Tympanum des Weibchens grösser als bei allen anderen Arten, mit 3 gezähnelten Querradern in der hyalinen Membran, diese seitlich durch eine enorme Verdickung der Medialis scharf leistenförmig begrenzt; Distalteil der Elytren regelmässig oval, nicht wie bei *armata* lappenförmig abgesetzt, sehr dicht und unregelmässig retikuliert; Costalfeld wesentlich schmaler als bei *armata*. Alae etwas grösser als bei *armata*, lappenförmig, rauchig-opak. Metasternalgrube schmal, längsgestellt. Vorderfemora ventro-external, Mittelfemora ventro-internal unbewehrt oder nur distal mit einigen kleinen Dörnchen, sonst wie bei *armata* bedornt. Vorder- und Hinterfemora dorsal gänzlich unbefornt. Bewehrung der Tibien wie bei *armata*, die Hintertibien aber mit 4 voll-

ständigen Dornenreihen. Supraanalplatte geradlinig dreieckig zulaufend. Ovipositor kräftig, breit, etwa 5mal so lang wie breit, vor dem Ende mit Querfältchen. Weibliche Subgenitalplatte distal stärker verjüngt als bei *armata*, terminal U-förmig ausgeschnitten, die Endloben krallenförmig und ziemlich lang, gut doppelt so lang wie bei *angusticauda*.

Körper L. ♀ 60—75 mm; Pronotum L. 16—17 mm, Metazone L. 7—7.5 mm, Elytren L. 16—17 mm, Costalfeld bis M.B. 5—5.5 mm, Tympanum ♀ L. 9.5—10 mm, B. 6—7 mm, Vorderfemora 25—26 mm, Vordertibien 29—30 mm, Hinterfemora 41—42 mm, Hintertibien 44—46 mm, Ovipositor L. 34—35.5 mm, B. 6.2—6.5 mm.

Type: 1 ♀, Pastaza, S.-Ecuador, ex Coll. Rolle (Museum Wien).

Paratype: 1 ♀, Iquitos, NW.-Brasilien nahe der peruanischen Grenze (Museum Stettin Nr. 383).

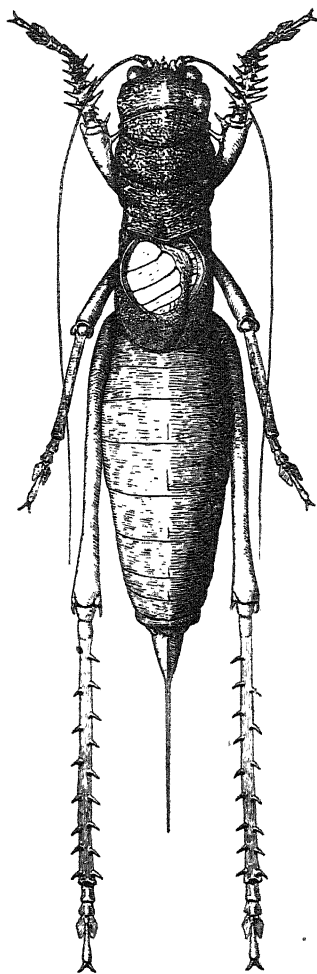


Fig. 1. *Panoploscelis specularis* n. sp., ♀, Habitusbild.

## ANATOMIE COMPARÉE DES GLANDES RÉTROCÉRÉBRALES ET DU SYMPATHIQUE CÉPHALIQUE DES INSECTES — SON UTILITÉ POUR LA SYSTÉMATIQUE

Par P. Cazal

Le sympathique céphalique et les glandes rétrocérébrales sont des organes primordiaux pour la vie de l'Insecte, constants dans les divers groupes, mais présentant d'importantes variations. Ils sont donc d'un grand intérêt pour les systématiciens.

Il est difficile de citer ici tous les auteurs qui s'en sont occupés. Signalons simplement les importants travaux de morphologie comparée de Hansström<sup>1</sup> (1940—42) sur les insectes inférieurs. Dans un travail récent<sup>2</sup> (1947), j'ai présenté une vue d'ensemble de cette anatomie comparée chez tous les insectes.

### 1° Le système stomatogastrique

Chez les formes primitives, il est constitué par un *ganglion frontal*, relié au cerveau par les nerfs labro-frontaux et le *nervus connectivus* de Baldus, auquel fait suite un *nerf recurrent* (cas des Ephémères). Chez les Odonates, les Blattoptéroïdes (Blattes, Mantres, Termites, Embioptères), les Phasmes et certains Plécoptères, s'individualise un *ganglion hypocérébral*. La portion distale du nerf récurrent est alors nommée *nerf oesophagien*. On retrouve cette disposition chez les Psocoptéroïdes (Psoques, Anoploures, Mallophages). Chez les Hémiptères, le *nervus connectivus* disparaît et parfois le ganglion hypocérébral regresse à son tour (Cicadidae).

Un type plus évolué apparaît chez les Orthoptères et chez les Dermaptères. Le *nervus connectivus* a disparu, le nerf oesophagien s'est dédoublé. Les Mégaloptères et les Planipennes sont du même type mais ont conservé le *nervus connectivus* (caractère primitif malgré leurs métamorphoses complètes). Les formes primitives des autres Holométaboles (certains Coléoptères, les Mécoptères, Aphaniptères et Nématocères) ont un sympathique céphalique identique à celui des Orthoptères. Puis une régression secondaire apparaît : le ganglion hypocérébral disparaît et parfois les nerfs oesophagiens (Lépidoptères, Coléoptères, Hyménoptères apocrites). Chez les Diptères supérieurs, un ganglion ventriculaire remplace progressivement le ganglion hypocérébral qui disparaît.

### 2° Les glandes rétrocérébrales

Elles sont constituées par les corps paracardiaques (= *corpora cardiaca*) et les corps allates (= *corpora allata*). Les premiers sont reliés au protocérébrum par les nerfs paracardiaques (= *nervi paracardiaci*). Les nerfs allates unissent les corps paracardiaques aux corps allates.

Les *nerfs paracardiaques* sont au nombre de quatre disposés par paires (nerfs internes et externes). Leurs origines protocérébrales et leur trajet intracérébral sont les mêmes dans tous les groupes. Par contre leur trajet extra-cérébral varie selon que les nerfs

<sup>1</sup> Inkretorische organe Sinnesorgane und Nervensystem des Kopfes einiger niederer Insektenordnungen — *Kungl. sv. Vetensk. Handl.*, 18, 1—266, 1940 Die Corpora cardiaca und corpora allata der Insekten — *Biol. generalis*, 15 485—531, 1942.

<sup>2</sup> Les glandes rétrocérébrales des Insectes — Thèse Sciences PARIS 1947, *Bull. Biologique*, Suppl. XXII, 1948.

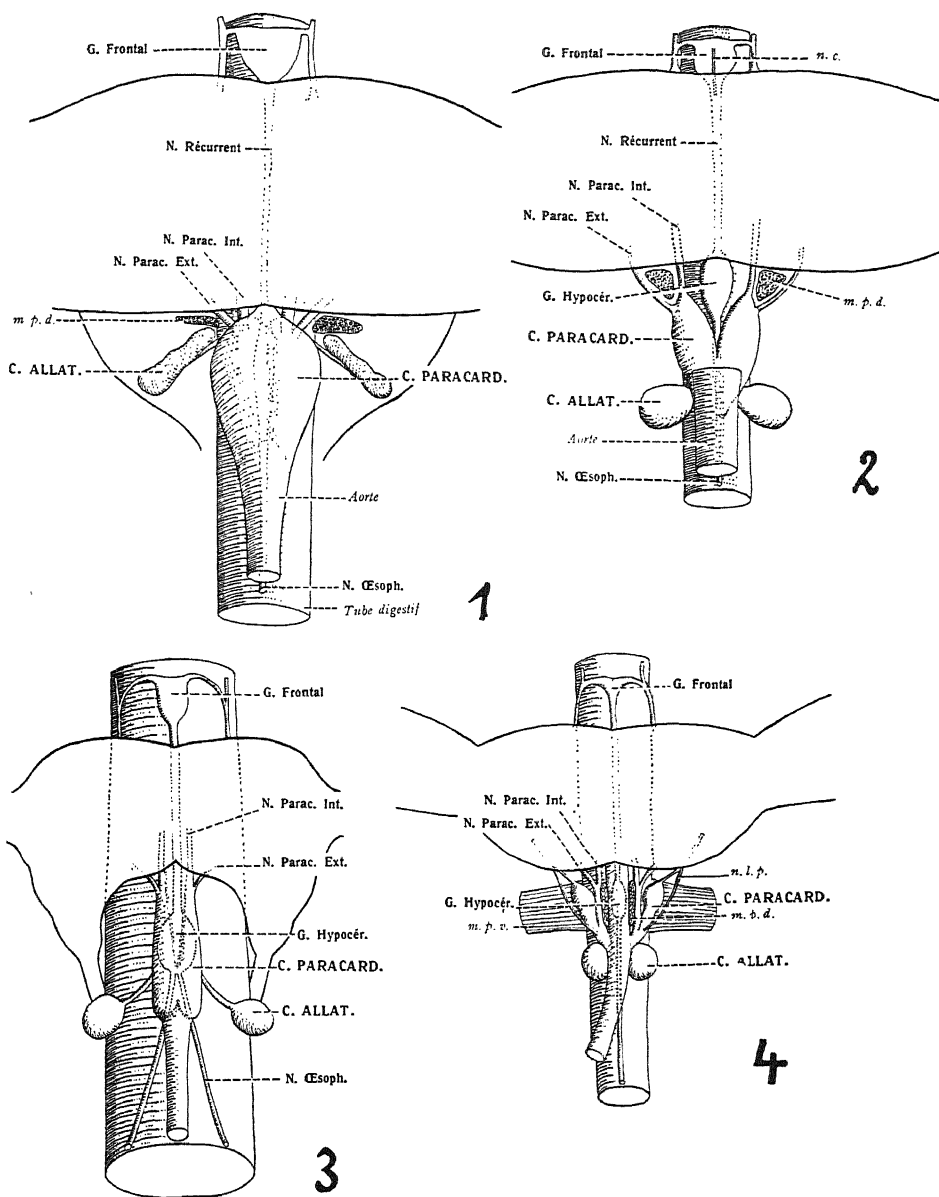


Fig. 1. Glandes rétrocébrales d'*Aeschna* (Odonates).

Fig. 2. Glandes rétrocébrales de *Mantis* (Dictyopteres).

Fig. 3. Glandes rétrocébrales de *Metrioptera* (Orthoptères).

Fig. 4. Glandes rétrocébrales de *Naucoris* (Hétéroptères).

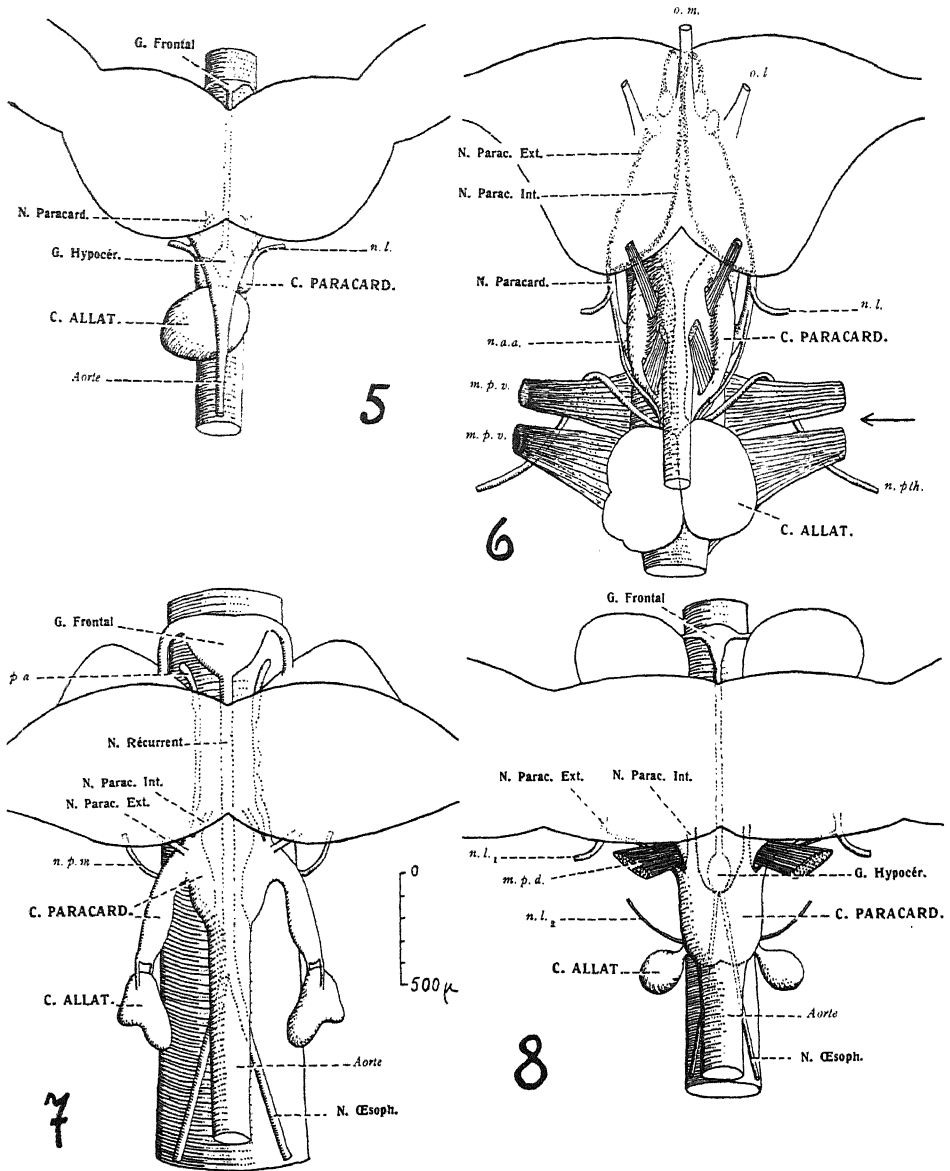


Fig. 5. Glandes rétrocébrales de *Pyrrhocoris* (Hétéroptères)

Fig. 6. Glandes rétrocébrales de *Tettigia* (Homoptères)

Fig. 7. Glandes rétrocébrales de *Hydrous* (Coléoptères).

Fig. 8. Glandes rétrocébrales de *Palpares* (Planipennes).

internes se fusionnent plus ou moins avec les externes. Trois dispositions peuvent être décrites :

— indépendance des nerfs paracardiaques : caractères primitif que l'on observe chez les Ephémères, Odonates, Blattes et Mantès, Plécoptères, Phasmes, Orthoptères, Psocoptéroïdes, Coléoptères (sauf Malacodermes), Mégaloptères, Planipennes, Trichoptères et Lépidoptères.

— fusion totale : caractère évolué observé chez les Thysanoptères, Homoptères, Mécoptères, Aphaniptères, Diptères et Hyménoptères.

Les *corps paracardiaques* sont primitivement intrapariétaux c'est-à-dire dans les parois aortiques. Dans certains groupes ils ne le sont plus que partiellement soit qu'ils produisent des expansions latérales (Cicadaires, Coléoptères), soit que seules leurs parties postérieures fusionnées se trouvent dans la paroi aortique (Hétéroptères). Parfois enfin, les corps paracardiaques n'ont plus de relations directes avec l'aorte, ils sont latéralisés. Cette évolution se produit indépendamment dans divers groupes (Mallophages, Anoploures, Thysanoptères, Trichoptères, Lépidoptères, Aphaniptères, certains Coléoptères).

La structure même des corps paracardiaques peut varier. Le cas le plus général, le cas primitif aussi, est celui où ils sont constitués par de nombreuses petites cellules chromophiles de taille moyenne. A l'opposé on rencontre des groupes où ils sont formés par un petit nombre de grandes cellules chromophiles. Parfois, on observe une régression des corps paracardiaques, qui peuvent ne contenir que deux ou trois cellules.

Les *corps allates* sont innervés par des fibres nerveuses venant du protocérébrum et traversant les corps paracardiaques, chez tous les groupes, sauf les Ephémères où ils sont innervés par le ganglion sous-oesophagien. Leur disposition primitive est latéro-ventrale. L'évolution se fait toujours de la même façon dans les différents phylums : les corps allates remontent sur la face dorsale de l'oesophage, deviennent contigus, puis fusionnent. Ce corps allate impair sous-aortique est assez fréquent (Embioptères, certains Plécoptères, Dermaptères, Psques, Gymnocérates, Cicadelles, Pucerons). Chez les Diptères, l'évolution se fait également vers la fusion des deux corps allates en une masse impaire, mais celle-ci est située au dessous de l'aorte.

### 3°) Application à la systématique des Ptérygotes

Les données précédentes confirment remarquablement la classification moderne des Insectes, telle qu'elle découle des conceptions de Lameere, de Martynov, de Jeanne, et précisent même certains points. Selon que l'insecte possède ou non un nervus connectivus, selon qu'il a un ou deux nerfs oesophagiens, selon la situation et la structure des corps paracardiaques et allates, selon enfin la disposition des nerfs paracardiaques, on peut tenter d'élaborer un tableau phylogénique de l'ensemble.

Les *Paléoptères* (Ephémères, Odonates) sont incontestablement les plus primitifs. Sur leur souche se greffent les plus primitifs des *Polynéoptères*, les *Blattoptéroïdes*, qui font un ensemble assez homogène à sympathique primitif : Blattes, Mantès, Termites auxquels on peut ajouter les Embioptères. Ceux-ci en effet se rattachent aux Blattoptéroïdes par leur sympathique. On observe alors dans ce phylum des formes à corps allates latéraux (Blattes, Mantès), contigus (Termites) ou fusionnés (Embioptères). Des Blattoptéroïdes dérivent les autres Polynéoptères : *Orthoptéroïdes* (Plécoptères, Phasmes, Orthoptères), et *Dermaptéroïdes* (Dermaptères). Ils ont perdu le nervus connectivus et acquis deux nerfs oesophagiens. Les corps allates sont fusionnés chez certains

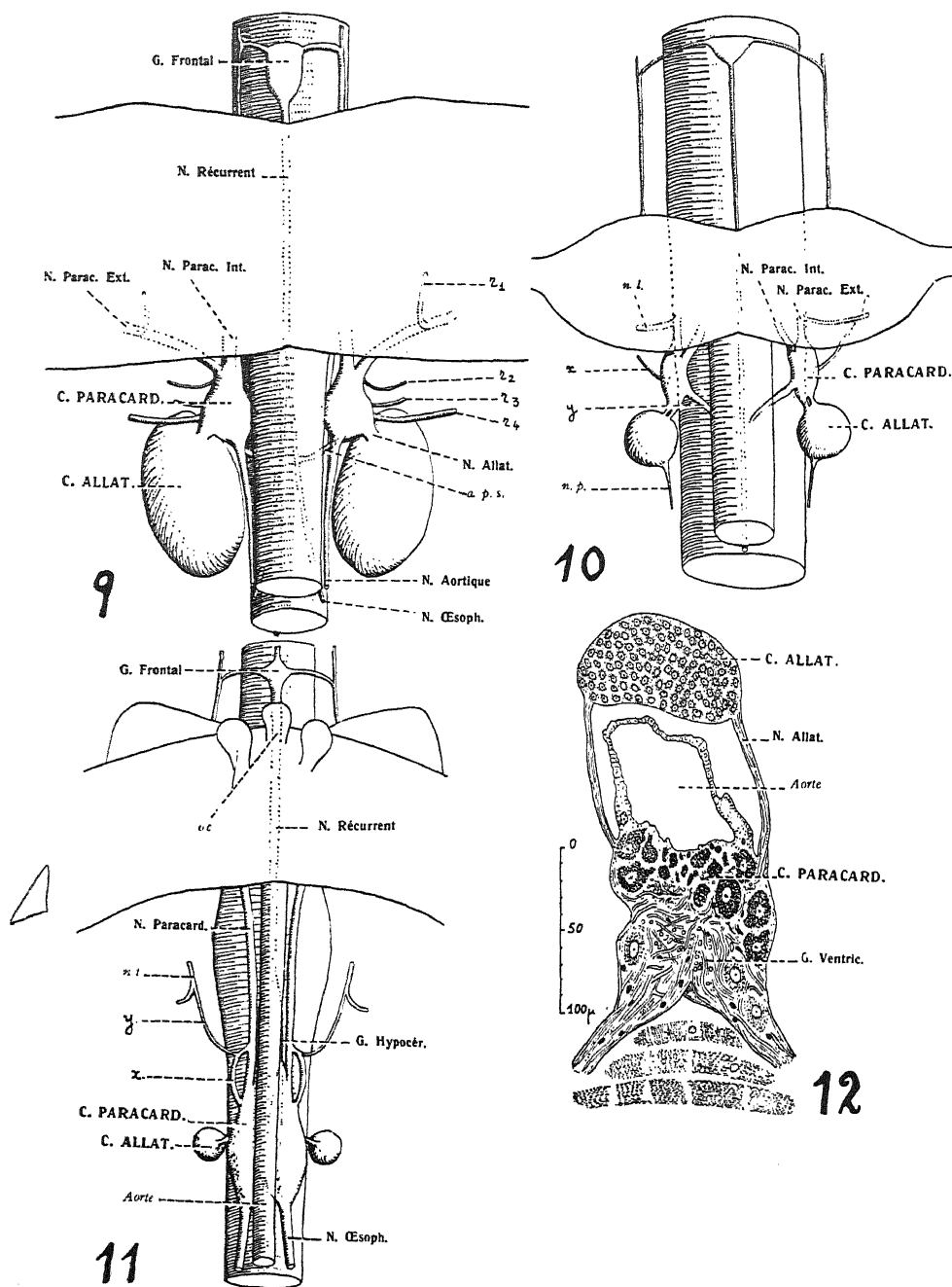


Fig. 9. Glandes rétrocérebrales de *Phryganea* (Trichoptères).

Fig. 10. Glandes rétrocérebrales de *Aporia* (Lepidoptères).

Fig. 11. Glandes rétrocérebrales de *Panorpa* (Mécoptères).

Fig. 12. Coupe transversale des glandes rétrocérebrales d'*Eristalis* (Diptères).



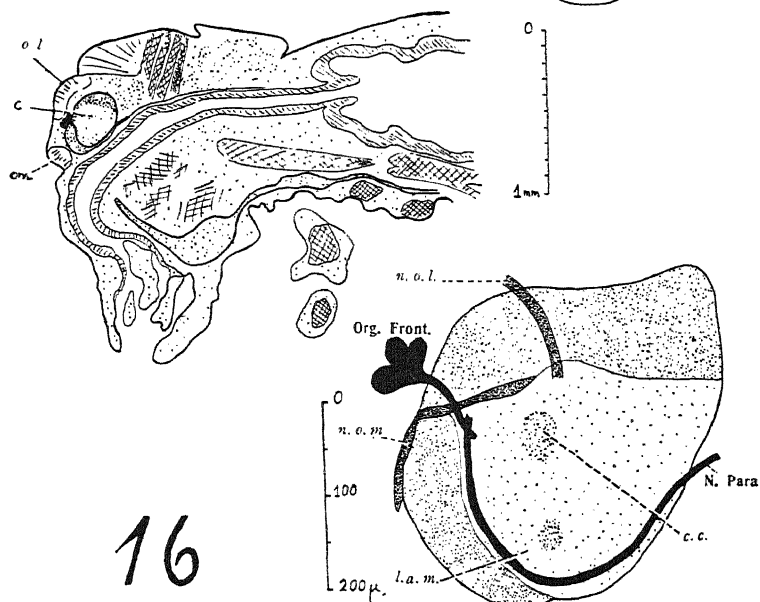
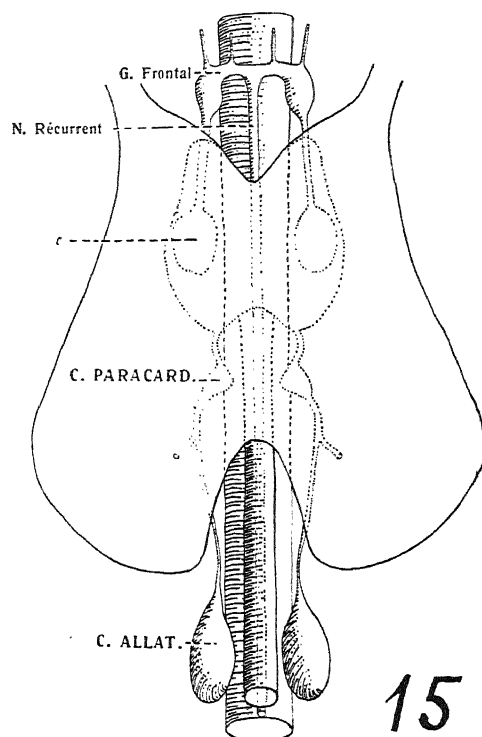
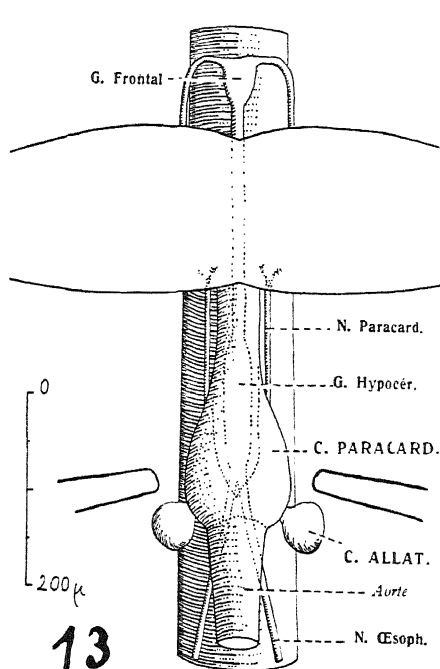


Fig. 13. Glandes rétrocébrales de *Selandria* (Hyménoptères).

Fig. 15. Glandes rétrocébrales de *Japyx*.

Fig. 16. Organe frontal et nerf paracardiaque de *Petrobius*.

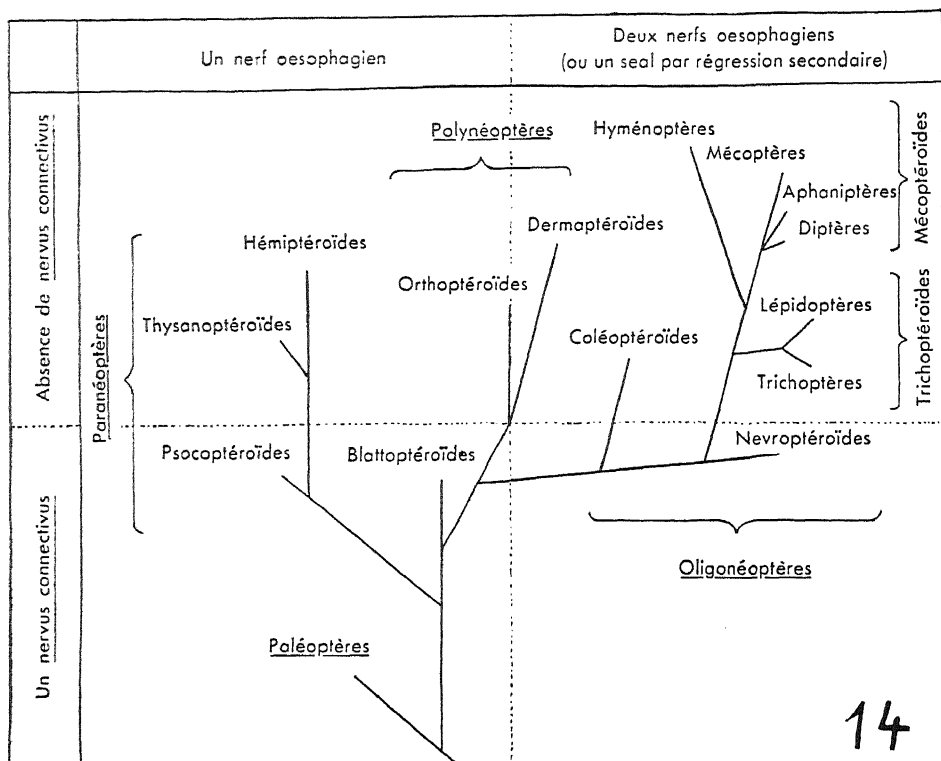


Fig. 14. Tableau phylogénique des Pterygotes d'après leurs caractères endocrino-sympathiques.

Plécoptères et chez les Dermaptères. Les corps paracardiaques et leurs nerfs sont toujours du type primitif.

Le grand groupe des *Paranéoptères* se rattache incontestablement aux *Blattoptéroïdes* dont ils ont le sympathique. Les *Psocoptéroïdes* (Psoques, Mallophages, Anoploures) ont conservé le nervus connectivus primitif. Les *Thysanoptéroïdes* (Thysanoptères) et les *Hémiptéroïdes* (Hétéroptères et Homoptères) l'ont perdu. Les plus primitifs des Hémiptéroïdes sont incontestablement les *Cryptocérates* pour les Hétéroptères, les *Cicadidae*, les *Psylles* et les *Cochenilles* pour les Homoptères; ces groupes ont en effet conservé la dualité des corps allates.

Parmi les *Oligonéoptères*, seuls les *Névroptéroïdes* (Mégaloptères, Planipennes) ont conservé le nervus connectivus primitif. Par leurs nerfs paracardiaques non fusionnés et leurs corps allates pairs, ils paraissent se rattacher à la souche des *Orthoptéroïdes*. Les *Coléoptéroïdes* (Coléoptères) constituent un phylum à part ayant conservé en partie les caractères primitifs (nerfs paracardiaques non fusionnés, deux corps allates) mais ayant perdu le nervus connectivus; on assiste dans ce groupe à un remaniement progressif des structures rétro-cérébrales et du sympathique: les corps paracardiaques se latéralisent et le sympathique céphalique regresse.

Le reste des *Oligonéoptères* ("panorpoïd complex" de Tylliard) se scinde en deux groupes selon que les nerfs paracardiaques sont indépendants ou fusionnés. Ils sont

indépendants chez les Trichoptères et les Lépidoptères, ensemble qui possède de nombreux autres caractères communs (corps paracardiaques latéralisés formés de quelques grandes cellules, corps allates également formés de cellules très grandes); on peut les réunir dans le super-ordre des *Trichoptéroïdes*. Chez les Mécoptères, les nerfs paracardiaques se fusionnent deux à deux, et l'on retrouve ce caractère évolué chez les Diptères, les Aphaniptères et les Hyménoptères. La situation des Aphaniptères est précisée par ce fait; par leurs corps paracardiaques latéralisés, ils se rapprochent aussi des Diptères inférieurs tels que les Tipulidae. Les Hyménoptères ont des glandes rétrocébrales très voisines de celles des Mécoptères. Cet ensemble d'ordres peut donc être rangé parmi les *Mécoptéroïdes*. Les Diptères sont particulièrement intéressants par le nombre de leurs espèces et la variété de leurs glandes rétrocébrales; on observe dans ce groupe toute l'évolution allant des corps allates latéralisés aux corps allates fusionnés.

#### 4°) *Le cas des Aptérygotes*

Seul le Japyx possède des corps allates bien développés. Tous les autres Aptérygotes en sont dépourvus. Par contre, on observe des corps paracardiaques chez diverses formes : Japygidae et Machilidae où ils sont très réduits (une à trois cellules), Lépismatidae où au contraire ils sont bien développés. L'origine des nerfs paracardiaques internes se trouve dans les organes frontaux pairs, ainsi que l'a montré Hansström chez les Machilidae.

Les Collembolés n'ont aucune structure endocrinienne de cet ordre.

Il est difficile sur ces données d'établir une phylogénie parcellaire d'un ensemble autrefois très vaste, ce qui explique les grandes différences constatées chez les groupes actuels. Par la présence des corps allates, le groupe le plus évolué paraît être celui des Japygidae.

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## CONTRIBUCION AL ESTUDIO DE LOS *CRYPTICUS* PALEARTICOS (Col. Tenebrionidae)

Por F. Español Coll

Tal como hoy se nos presenta, el género *Crypticus* viene constituido por 83 formas de las cuales 71 son paleárticas y distribuidas por las regiones montañosas, esteparias, litorales y hasta desérticas de Europa, Norte de Africa y Asia, desde las Canarias hasta Mongolia y Siberia oriental. Este importante conjunto ofrece un aspecto general bastante homogéneo y una perfecta concordancia en diferentes caracteres externos, todo lo que parece venir en apoyo de una unidad genérica; el examen de la genitalia masculina permite, sin embargo, comprobar diferentes tipos de armadura genital, que según nuestra opinión y por lo que se refiere a la representación paleártica, conducen al establecimiento de tres grupos de especies bien diferenciados que por el momento y dado el carácter limitado de nuestro estudio serán considerados como agrupaciones todas ellas subordinadas a los *Crypticus*.

### Primer Grupo (Figs. 1 y 2)

Caracterizado por el órgano copulador masculino asimétrico y por la constitución tan particular de la parte apical del mismo, la cual diferencia tres piezas: dos laterales y una dorsal; las primeras, que consideraremos homólogas a las lacinias de los *Dendarini*, se nos presentan notablemente desarrolladas, la derecha mayor que la izquierda y siempre de forma diferente; la dorsal es de forma alargada, más o menos desviada hacia la izquierda y más o menos torcida, hacia la base se ensancha y diferencia dos lóbulos con los que se apoya, a cada lado, sobre la parte basal; a menudo existe en ella un surco longitudinal medio, testigo del origen doble de la pieza, que separa los dos lóbulos basales y desaparece hacia el ápice; en la base de la pieza dorsal penetra el canal eyaculador, cuya extremidad, desprovista de protección quitinosa, se suelda a dicha pieza; en raras excepciones el canal eyaculador no se suelda a la base de la pieza dorsal y constituye entonces una nueva pieza interna, libre y quitinizada en su parte ventral; en realidad la pieza dorsal resulta de la soldadura de los parámetros y se corresponde con la parte apical de la vaina parameral de los restantes grupos de tenebriónidos, pero, profundamente modificada<sup>1</sup>. Es digna también de mencionarse en este grupo la gran variabilidad que se observa en el desarrollo de las alas inferiores, de tipo cantaridiforme y en proceso más o menos avanzado de reducción, llegando en algunos casos a presentarse casi completamente atrofiadas.

Grupo esencialmente paleártico en el que figuran las siguientes agrupaciones subgenéricas:

*Crypticus* s. str., con un total de 36 especies: *quisquilius* Payk. (tipo del grupo), *paradoxus* Reitt., *gibbulus* Quens., *navicularis* Brull., *canariensis* Woll., *oblongus* Woll., *punctatissimus* Woll., *calvus* Woll., *minutus* Brull., *nitidulus* Woll., *pubens* Fairm., *dactylispinus* Mars., *capsianus* Ant., *schramni* Ant., *petreus* Esc., *faucium* Ant., *tachdir-tensis* Ant., *rhaticus* Ant., *iblanensis* Ant., *arandai* Esc., *major* Ant., *azruensis* Esc., *lecerfi* Thér., *impunctatus* Thér., *atlasicus* Thér., *tenietensis* Desbr., *obesus* Luc., *cyre-*

<sup>1</sup> Para más detalles véase Antoine (EOS, t. XX, cuad. 3 y 4, 1945), con el cual estamos de acuerdo en la interpretación de las piezas del edeagus.

*naicus* Koch., *zuberi* Mars., *latiusculus* Mén., *pentheri* Reitt., *castaneus* Baud., *thessalicus* Reitt., *fairmairei* Desbr., *ovalis* Ball. y *sibiricus* Silsky.

*Ulomoides* Esc., notable por el cuerpo de lados paralelos, deprimido en el dorso y de color rojo ladrillo o castaño, las antenas robustas, la puntuación de la cabeza fuerte y profunda y las estrias de los élitros con puntos grandes, redondos y profundos. Comprende sólo 3 especies: *punctatolineatus* Fairm., *viaticus* Fairm. y *frigidus* Esc.

*Crypticopsis* Ant., caracterizado por el mentón sin quilla longitudinal media, las tibias anteriores cortadas oblicuamente en la extremidad, los tarsos posteriores tan largos como las tibias correspondientes y el canal eyaculador libre y con el extremo quitinizado. Se reunen en él los *C. corticeus* Fairm. y *meridionalis* Esc.

*Seriscius* Motsch., constituido por las especies asiáticas no mediterráneas, *pubescens* Motsch., *ovatulus* Reitt. y *rufipes* Gebl., todas ellas muy próximas y que tienen de común la pubescencia densa y uniforme que cubre las partes dorsal y ventral del cuerpo y el órgano copulador con la parte basal prolongada en un saliente anguloso que separa los dos lóbulos de la pieza dorsal.

Por lo que respecta a la distribución geográfica, sin dar un valor absoluto a nuestras palabras, consideraremos a este primer grupo de *Crypticus* como un típico elemento paleártico, de probable origen angariano y que en su avance hacia el oeste ha colonizado Europa y la región mediterránea hasta Canarias. Su repartición actual muestra una fuerte dominancia en la región mediterránea, sobre todo en Marruecos, en cuyo país el número de las formas registradas (22) alcanza casi la mitad de las conocidas; muy abundante también en Canarias, con un total de 7 representantes.

#### *Segundo Grupo: Subgén. Pseudoseriscius nov. (Fig. 3)*

El conjunto de los *Seriscius*, tal como viene constituido en la actualidad, diferencia dos series de especies susceptibles, a nuestro juicio, de aislarse por la diferente conformación del edeagus: una formada por las especies asiáticas no mediterráneas (*pubescens*, *ovatulus* y *rufipes*) caracterizada por el copulador asimétrico, muy evolucionado y análogo en su conformación al de los *Crypticus* s. str.; y la otra integrada por las restantes especies de distribución circummediterránea, con órgano copulador simétrico, poco evolucionado y de forma sensiblemente distinta al del grupo anterior. Como sea que cuando Motschulsky estableció la agrupación de los *Seriscius* tenía a la vista representantes asiáticos no mediterráneos, son éstos los que deben considerarse como típicos *Seriscius* y conservar, tal como hemos ya indicado, su estrecha dependencia a los *Crypticus* del primer grupo. Para las especies mediterráneas precisa pues establecer otra agrupación subgenérica bien separada de los verdaderos *Seriscius* a los cuales venían hasta hoy reunidos y para la que proponemos el nombre de *Pseudoseriscius*.

Los *Pseudoseriscius* forman un grupo muy homogéneo caracterizado por el órgano copulador simétrico y por las tres piezas de la parte apical del mismo de forma muy diferente a las del grupo anterior: las dos laterales (lacinias), de desarrollo normal y por lo común muy bien diferenciadas, se nos presentan iguales en todos sus detalles y su forma acostumbra a ser estrecha y alargada; la dorsal, sensiblemente mayor que las laterales, es de forma completamente normal, no desviada ni torcida hacia la extremidad, como tampoco bilobada en la base; en la cara ventral de esta pieza viene aplicada la extremidad del canal eyaculador protegida por una formación quitinosa, más o menos aparente. A la citada conformación del edeagus acompañan otros varios caracteres comunes a todos los representantes del subgénero, entre los que citaremos: el cuerpo cubierto de pubescencia corta y acostada que vela o casi vela

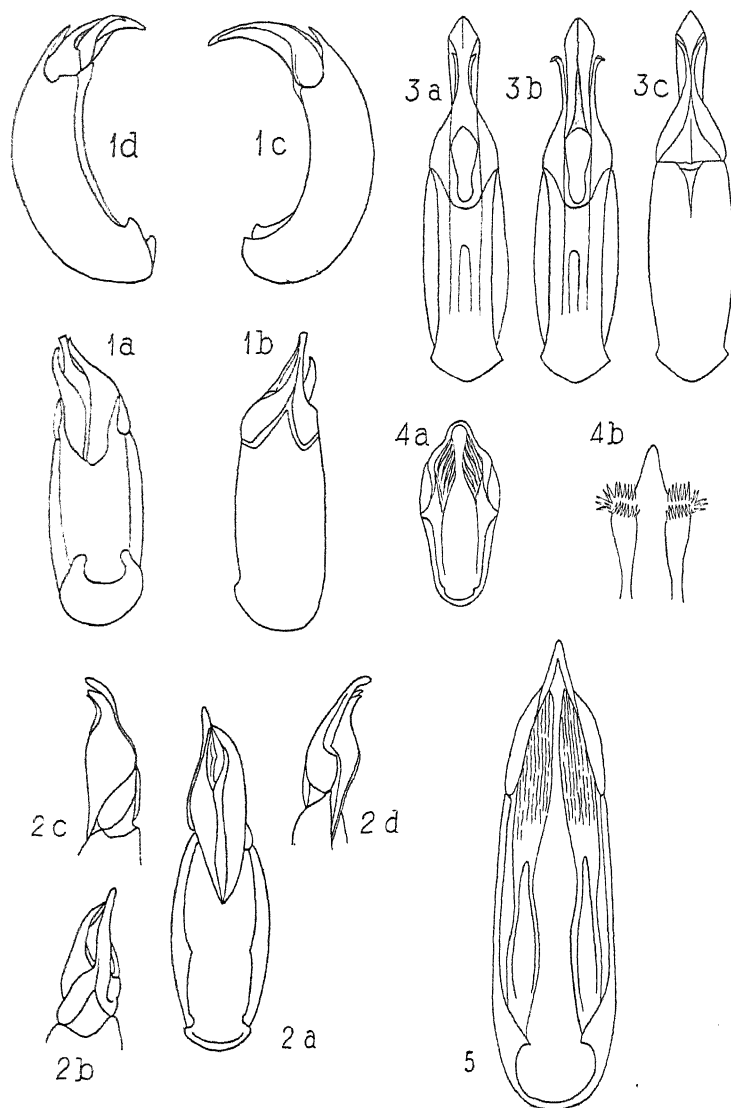


Fig. 1. *Crypticus (Seriscius) ovatulus* Reitt.: 1a, órgano copulador, cara ventral; 1b, cara dorsal; 1c, perfil derecho; 1d, perfil izquierdo.

Fig. 2. *Crypticus (s. str.) tenietensis* Desbr.: 2a, órgano copulador, cara ventral; 2b, cara dorsal (región apical); 2c, perfil derecho (región apical); 2d, perfil izquierdo (región apical).

Fig. 3. *Crypticus (Pseudoseriscius) pruinosus* Duf.: 3a, órgano copulador, cara ventral; 3b, la misma cara ventral con las lacinias separadas de su posición normal; 3c, cara dorsal.

Fig. 4. *Crypticus (Lamprocrypticus) zophosioides* Heyd.: 4a, órgano copulador, cara ventral; 4b, lóbulo medio, cara ventral (región apical).

Fig. 5. *Crypticus (Lamprocrypticus) alpinus* Com.: órgano copulador, cara ventral.

los tegumentos, los ojos bien desarrollados en su parte inferior, la cual presenta un contorno más o menos circular, las tibias fuertemente espinulosas, el primer artejo de los tarsos anteriores ensanchado en la extremidad, el mesosternón no o apenas excavado, los élitros libres o con una ligera tendencia a soldarse y las alas inferiores en franco proceso de reducción, siendo en ellas característico la forma estrecha y alargada, la sensible atenuación de las nerviaciones y el poco desarrollo de la zona distal.

Grupo típicamente circummediterráneo en el que se incluyen los siguientes representantes: *pruinus* Duf. (tipo del subgénero), *adpersus* Küst. (*nebulosus* Fairm.), *timaditensis* Thér., *olivieri* Desbr., *helvolus* Küst., *cameroni* Reitt., *griseovestis* Fairm. (*pellitus* Reitt., *mollis* Reitt.), *uniformis* Reitt., *fonti* Esc., *alluaudi* Peyer. y *maculosus* Fairm. (*murinus* All.). No incluimos en la lista precedente el *Seriscius explorator* Geb. por no haber podido examinar representante alguno de esta especie e ignorar por lo tanto si pertenece al subgénero que describimos.

Como hemos ya señalado, los *Pseudoseriscius* son insectos de distribución mediterránea y conocidos del Norte de Africa y Oriente Medio desde Canarias, Sáhara español y Marruecos occidental hasta Egipto, Palestina y Siria; conocidos también del sur de Europa, desde la Península ibérica hasta el Adriático.

### *Tercer Grupo: Subgén. Lamprocrypticus nov. (Figs. 4 y 5)*

Caracterizado por el órgano copulador simétrico y de forma muy sencilla; viene constituido por la vaina parameral que aloja a lo largo de su cara ventral la extremidad del canal eyaculador más o menos modificada. En dicha vaina, la separación de las partes basal y apical es poco aparente y la sutura de unión entre ambas viene, por lo general, borrada en el dorso; la parte apical tiene, en la zona de unión con la basal, la misma anchura que ésta, estrechándose luego hacia el ápice, el cual se presenta en punta aguzada, rara vez redonda. La pieza ventral media responde, como ya hemos señalado, a la parte terminal del canal eyaculador que se apoya a lo largo de la cara ventral de la vaina parameral y que viene protegida por unas formaciones quitinosas que diferencian, sea series de lobulillos espiniformes, sea rugosidades o estriaciones bastante sensibles. El aspecto muy diferente que a primera vista presenta el edeagus en algunos ejemplares es más aparente que real y debido únicamente a la distinta posición que ocupa la extremidad del canal eyaculador, pieza que indudablemente puede deslizarse a lo largo de la vaina parameral. Es característico también en este grupo el cuerpo convexo y lustroso, sin diferenciar pubescencia alguna en la parte superior del mismo o todo lo más con cerdillas cortas que en ningún caso velan el fondo, la puntuación muy fina, las alas inferiores atrofiadas, las antenas gráciles, poco engrosadas hacia la extremidad y bastante largas, alcanzando la base del protórax o acercándosele mucho, el protórax con los lados redondeados y estrechados hacia el borde anterior, la base del mismo en curva entrante o recta y con los ángulos posteriores bien marcados, sea rectos, sea agudos y a veces salientes hacia atrás, las tibias gráciles y muy poco ensanchadas en la extremidad, incluso las anteriores; todas ellas finamente espinulosas en el lado externo, los tarsos estrechos y largos, con el primer artejo notablemente alargado, en los anteriores el citado artejo no se ensancha o lo hace muy debilmente en la extremidad, siendo los siguientes no o apenas transversos.

Este nuevo subgénero se encuentra distanciado de las especies del primer grupo, a parte el cuerpo lustroso y otros detalles de la morfología externa, por el edeagus que responde a un tipo de conformación completamente distinto. Diferente a su vez de los *Pseudoseriscius* por la pubescencia nula o de cerdillas espaciadas que en ningún

caso velan los tegumentos, por el color y brillo del cuerpo bien distintos, por las alas membranosas atrofiadas, las tibias muy finamente espinulosas, los tarsos anteriores con el primer artejo más alargado y no o apenas ensanchado en la extremidad y en fin por el órgano copulador masculino diferentemente conformado. Quizás más próximo a *Ellipsodes* con el cual presenta de común el cuerpo brillante, convexo y muy finamente punteado, los élitros con una tendencia muy manifiesta a soldarse, las alas inferiores atrofiadas y el edeagus que responde al mismo tipo; esto no obstante, existen sensibles diferencias que apoyan su aislamiento, entre las más importantes citaremos: la forma distinta de los apéndices del prosternón y del mesosternón, la forma también diferente del metasternón y la posición oblicua de las coxas posteriores.

Subgénero francamente orófilo del que conocemos 6 representantes distribuidos por el norte de Italia, confines algeriano-marroquíes y sobre todo por la Península ibérica: *alpinus* Com. (tipo del subgénero), *tonsilis* Bed., *minutissimus* Esc., *pusillus* Rosh., *keraatzi* Bris. y *zophosioides* Heyd.

Dejamos de incluir en los tres grupos estudiados el *C. tauri* Pic de Asia Menor y el *C. subpunctatus* Walk. de Egipto por no conocer estas especies e ignorar por lo tanto a cual de ellos deben colocarse.

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#### Résumé

Au cours de l'étude que j'ai pu faire du matériel du genre *Crypticus* constitué notamment par les collections de l'Institut Espagnol d'Entomologie de Madrid et du Musée des Sciences Naturelles de Barcelone, je suis parvenu à la conclusion suivante :

Pris en son ensemble, les *Crypticus* paléarctiques se partagent dans trois groupes d'espèces distincts par l'armure génitale mâle : Dans le premier groupe, caractérisé par l'organe copulateur asymétrique, très évolué, les lacinia très développées et toujours inégales, la partie terminale de la gaine paramérique plus ou moins dévié vers la gauche, plus ou moins tordue, à base élargie et bilobée s'appuyant de chaque côté sur la pièce basilaire, se rangent les 4 suivantes coupes sous-génériques : *Crypticus* s. str., *Ulomoides* Esc., *Crypticopsis* Ant. et *Seriscius* vrais de Motschulsky confinés à l'Asie paléarctique non méditerranéenne. Ainsi composé ce premier groupe c'est un typique élément euro-asiatique et dont la souche individualisée dans l'Asie a émigré vers l'ouest et a pu s'installer en Europe et région méditerranéenne jusqu'à les Canaries.

Le deuxième groupe (sous-gen. *Pseudoseriscius* nov.) est caractérisé par l'organe copulateur symétrique, peu évolué, les lacinia à développement normale et toujours égales, la partie terminale de la gaine paramérique pas dévié ni tordue et à base non bilobée. Il existe bien dans ce groupe des remarquables convergences externes avec



les *Seriscius*, notamment la dense pubescence qui voile les téguments, mais bien isolés par la conformation si différente du pénis. La dense pubescence et la structure de l'organe copulateur l'éloignent d'ailleurs des autres sous-genres de *Crypticus*. Les *Pseudoseriscius* sont des *Crypticus* répandus dans toute la région méditerranéenne, ils colonisent aussi les Canaries (Fuerteventura) et Rio de Oro.

Le troisième groupe (sous-gen. *Lamprocrypticus* nov.) s'écarte des deux précédents par l'organe copulateur symétrique, très simple et constitué par la gaine paramérique qui loge dans sa face ventrale l'extrémité du canal éjaculateur plus ou moins modifié, les lacinia ne sont pas apparentes. Au point de vue des caractères externes ce groupe est remarquable par le corps brillant à reflet bronzé, les téguments finement ponctués et l'atrophie des ailes membraneuses. Les *Lamprocrypticus* sont plutôt voisins du genre *Ellipsodes* Woll., mais ils s'éloignent de celui-ci par la différente conformation du prosternum, du mesosternum et du metasternum, et par la position nettement oblique des coxes postérieures. On connaît des représentants de ce groupe dans la Péninsule ibérique, le Maroc orientale, l'Algérie occidentale et l'Italie du Nord.

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### XIII.— LE GENRE *ANTHEMUS* HOWARD NOUVEAU POUR LA FAUNE ÉTHIOPIENNE (Hym. Chalcidoidea Encyrtidae)

Par J. Ghesquière

En 1896, Howard crée le gn. *Anthemus* dans la famille des *Mymaridae* (*Anaphini*). Après lui, Dalla Torre (1898), Ashmead (1904), Schmiedeknecht (1909), Girault (1911, 1915, 1928), Ramakrishna (1925), Mani (1938), Ceballos (1943), avec certaines variantes, maintiennent ce genre dans cette même famille. Seul, Ceballos dans son excellent travail sur les Hyménoptères d'Espagne, laisse sous-entendre que les *Anthemus* ne seraient pas des Mymarides.

Cependant en 1922, puis en 1929, Mercet discute les affinités du genre *Anthemus* et crée pour le recevoir, la sous-famille nouvelle des *Antheminae* qu'il incorpore à juste titre dans la famille des *Encyrtidae*, à côté des *Arrhenophaginae*. Il est suivi en cela par Blood et Masi (in litt. apud Mercet 1922), Ferrière (1927), Balachowsky (1928) et Thompson (1944).

D'après Mercet et Ferrière, la s-fam. des Anthémines ne comprend qu'un seul genre. Girault a pourtant décrit brièvement dans les Mymarides, trois autres genres qu'il rapproche du gn. *Anthemus*, soit *Anthemiella* Gir. 1911, *Paranthemus* Gir. 1915 et *Metanthemus* Gir. 1928. Le premier, *Anthemiella*, accepté par Ferrière (1927) comme un Mymaride vrai, est placé dans cette même famille en synonymie du gn. *Parallelaptera* Enoch 1909 par Thompson (1944); les deux autres, *Paranthemus* et *Metanthemus* doivent, jusqu'à nouvel ordre, être maintenus dans les Anthémines. Seule, la consultation du matériel de Girault permettra de régler cette question avec certitude.

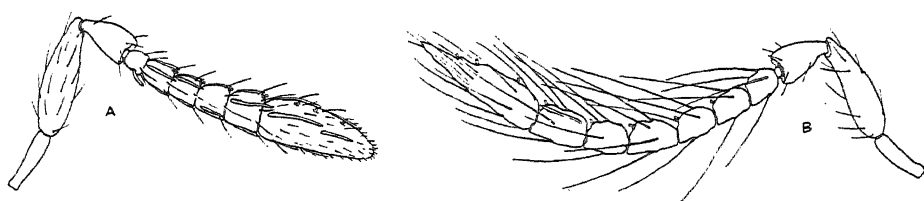
Le gn. *Hexalis* créé par Bakkendorf dans les Aphélinides, passe dans le gn. *Anthemus* How. comme je l'ai démontré antérieurement (1948). D'autre part, j'élèverai au rang d'espèce *A. chionaspidis* var. *hilli* Dodd, ses caractères étant suffisants pour le séparer complètement de l'espèce d'Howard.

Un des *Anthemus* récoltés par Hill (1915) en Australie septentrionale, ainsi que l'*Anthemus* sp. n. récolté par Balachowsky (1926) en Algérie et déterminé comme tel par Ferrière, restent inédits. Les exemplaires du premier seraient déposés à Melbourne, ceux du second au British Museum (Ferrière dix.).

Parmi les Hyménoptères parasites de Diaspides obtenus d'élevage au Congo belge, j'ai reconnu un *Anthemus* dont les caractéristiques ne correspondent avec aucune des descriptions publiées à ce jour. Je donnerai donc ci-dessous la diagnose de cette espèce nouvelle.

#### *Anthemus africanaspidis* sp. n.

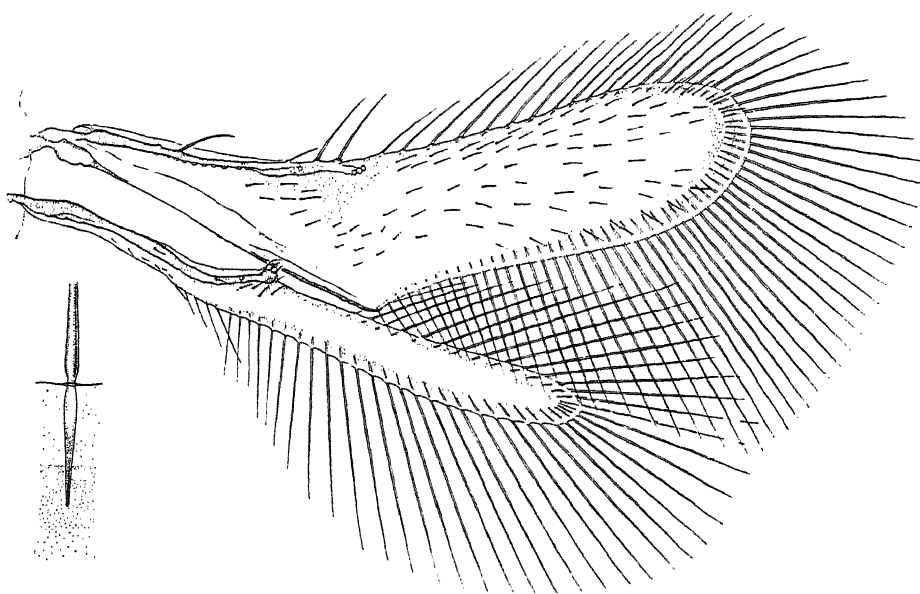
♀ : Long. 0,68 mm., 0,73 mm. tarière comprise. Corps testacé plus ou moins foncé; mandibules plus claires; bord antérieur du pronotum et du mésonotum un peu plus foncé; tête avec une fascie claire au milieu du front; yeux noirs; ailes lavées de jaunâtre, à nervures brunes, bordure antérieure embrunie, plus largement au niveau de la marginale et de la stigmale, bordure des parties apicale et postérieure hyaline avec une bande submarginale embrunie; antennes et pattes un peu plus claires que le corps; fémurs médians à base jaune clair; pilosité noire.



*Anthemus africanus* Ghesq.

fig. 1. A, antenne ♀

B, antenne ♂



*Anthemus africanus* Ghesq.

fig. 2. Ailes antérieure et postérieure et détail de l'insertion d'un cil marginal.

Tête vue de face subcarrée, un peu plus longue que large, finement striolée; vertex 4 fois plus large que les yeux; ocelles en triangle isocèle obtus, les postérieurs séparés des yeux d'une distance égale à leur diamètre; les yeux petits, convexes, ovales; joues larges. Antennes claviformes de 8 articles (fig. 1, A), un peu plus longues que la moitié du corps, insérées au milieu de la face au niveau de la ligne imaginaire reliant la base des yeux; radicule longue, 4 fois plus longue que large, un peu plus longue que le pédicelle; scape fusiforme sublanolé, aussi long que I à IV du funicule, pilosité clairsemée; pédicelle aussi long que I et II du funicule réunis, sa plus grande largeur égale celle du IV du funicule; funicule de 5 articles, I à IV à peine plus longs que larges, V aussi long que large, I nettement plus petit que les suivants qui s'élargissent progressivement; massue aussi longue que le scape, un peu moins longue que les 4 derniers articles du funicule réunis, plus épaisse que le scape ou le dernier article du funicule, terminée à son sommet par quelques courts poils et quelques sensilla tuberculeux

translucides; I du funicule avec un sensillum filiforme (rhinarium) parfois obliquement disposé, les autres articles avec 4 sensilla filiformes et à la partie antérieure du sommet des articles II à V un sensillum papilliforme (en forme de bouton); massue avec 2 séries de 4 sensilla filiformes et 3 sensilla papilliformes alignés longitudinalement dans le  $1/3$  médian; pilosité suivant figure. Pronotum très court aussi large que le corps, glabre à l'exception de 2 poils latéraux. Mésonotum 2 fois plus large que long, très finement striolé longitudinalement, glabre à l'exception de 2 soies au bord postérieur. Axilles très étroitement aigus, séparés à l'apex. Ecusson finement striolé longitudinalement, grand, plus long que le mésonotum, faiblement transverse, cotés antérieurs concaves, cotés postérieurs convexes, largement arrondi à l'apex, glabre à l'exception de 2 longues soies dans sa partie centrale, une petite épine latérale bien visible au milieu des cotés. Endophragme bien visible, fortement convergent, subaigu, à sommet obtus, s'avancant jusqu'au centre de l'abdomen. Propodeum très court et courbé. Ailes étroites (fig. 2). Ailes antérieures cils compris, un peu plus longues que la longueur totale du corps, dépassant de moitié le sommet de l'abdomen, bord antérieur concave, bord postérieur en angle obtus, les bords antérieur et postérieur de la partie distale parallèles, pilosité discale très clairsemée et relativement longue; cils marginaux très longs, les plus longs situés au bord inférieur de la partie distale du disque et 2 fois plus longs que la plus grande largeur de celui-ci; nervures presque aussi longues que la moitié de l'aile, submarginale  $2\frac{1}{2}$  fois plus longue que la marginale qui est un peu plus épaisse, au milieu de la submarginale une soie longue et courbée toujours précédée d'un petit tubercule inerme, dans la portion distale de la marginale une soie 3 fois plus petite que les 2 suivantes; stigmale un peu moins épaisse que la marginale, 3 fois plus courte que celle-ci et terminée par 3 sensilla placoides en ligne, le médian plus grand que les 2 autres. Ailes postérieures très étroites, à bords subparallèles distalement, portant 4 cils sous la partie distale de la nervure et une rangée de 5 à 6 cils au bord postérieur de la partie proximale; disque glabre; cils marginaux très longs, 4 fois plus longs que la plus grande largeur du disque, un peu plus courts que ceux des ailes antérieures. Pattes à tarsi de 4 articles; éperon des tibias antérieurs long et courbé, plus long que le métatarse, celui des tibias médians à peine plus court que le métatarse, celui des tibias postérieurs  $1/2$  plus petit que le métatarse.

Abdomen sessile, à peine plus court que le thorax, se rétrécissant faiblement et progressivement vers l'apex qui est arrondi; tarière peu proéminente, partie visible 0,05 mm. de longueur.

♂ : Long. 0,65 mm. semblable à la ♀. Antennes filiformes, de 9 articles (fig. 1, B), environ les  $3/4$  de la longueur du corps; scape plus ou moins fusiforme, courbé dans sa partie distale, sa plus grande largeur dans la portion proximale; pédicelle semblable à celui de la ♀ mais un peu plus long; funicule de 6 articles un peu dilatés unilatéralement comme chez tous les ♂ d'*Anthemus* (voir figure), s'épaississant et s'allongeant faiblement de la base au sommet, le dernier à peine 2 fois plus long que I; massue conique, allongée, aussi longue que les 3 derniers articles du funicule réunis, à peine plus large que VI, funicule et massue avec de très longs cils en verticilles; un sensillum papilliforme sur la partie antérieure des articles II à VI du funicule et 3 autres disposés longitudinalement sur la massue; lorsqu'il existe un sensillum papilliforme sur le I du funicule, le V en est dépourvu et vice versa.

*Congo belge*.— Lac Kivu : Mulungu, V—1938, réc. J. Ghesquière n° 6471 c, syntype 4 ♀♀, allotype 3 ♂♂ sur lames, paratypes 27 ♀♀ 12 ♂♂ sur lames. (Types au Musée du Congo, Tervuren, Belgique).

*Biologie*.— Parasite d'une Cochenille de la fam. des Diaspides, *Africaspis chionaspiformis* (Newst.) (syn. *Pinnaspis cassiae* Newst.), vivant en colonies sur les rameaux d'une Légumineuse Césalpiniée, *Erythrina abyssinica* Lam., arbre d'ombrage des plantations de Cafésiers.

*Affinités*.— *A. africanaspidis* Ghesq. est, par le ♀, voisin de *A. funicularis* (Bakk.), mais ce dernier est fuligineux; les ailes de ces deux espèces sont fort semblables, sauf la pilosité de la marginale et du disque qui est plus dense chez le second. Il s'éloigne de toutes les autres espèces connues par son abdomen très court, un peu plus petit que le thorax, sa tarière à partie visible très courte, ses ailes antérieures à pilosité clairsemée et assez longue, ses ailes postérieures à disque glabre rappelant *A. emersoni* Gir. La submarginale des ailes antérieures de *A. africanaspidis* Ghesq. porte un long cil médian précédé d'un tubercule inerme. Les auteurs ne font le plus souvent aucune allusion à la chétotaxie des nervures, celle-ci présente pourtant des caractères constants ayant une réelle valeur spécifique.

LISTE DES ANTHEMINAE MERCET 1922 (ENCYRTIDAE).—  
DISPERSION GÉOGRAPHIQUE ET HOTES.

*Paranthemus* Girault

Girault, *Mem. Qd. Mus.*, 3, p. 165, 1915.

♂ — antennes de 3 articles, ♀ inconnue.

1. — *P. spenceri* Gir. ♂ (génotype)

Girault, l. c.

Queensland

Hôte inconnu.

*Metanthemus* Girault

Girault, *Some New Hexapods stolen from Authority*, p. 4, Brisbane 1928 (pub. priv.).

(♂?) — antennes de 5 articles, funicule 2.

1. — *M. aureus* Gir. ♂? (génotype)

Girault, l. c.

Queensland

Hôte inconnu.

*Anthemus* Howard

Howard et Ashmead, *Proc. U.S. Nat. Mus.*, 18, p. 643, 1896.

Mercet, *Bol. R. Soc. Esp. Hist. Nat.*, 22, p. 365, 1922. — *Rev. Biol.*

*Forest. y Limnol.*, 1, ser. B, p. 6, 1929.

♂ — antennes de 9 articles, funicule 6; ♀ — antennes de 8 ou 9 articles, funicule 6 ou 5.

1. — *A. chionaspidis* How. ♂♀ (génotype)

Howard et Ashmead, l. c.; Dalla Torre, *Cat. Hym.*, V, p. 427, 1898; Ashmead, *Mem. Carn. Mus.*, 1, p. 363, 1904; Schmiedeknecht, *Gen. Ins.*, 97, p. 498, 1909; Mercet, *Bol. R. Soc. Esp. Hist. Nat.*

Ceylan:

Pundoloya

*Poliaspis graminis* (Green) (= *Chionaspis*) sur Graminée.

22, p. 367, 1922; Ramakrishna, *Spol. Zeyl.*, 13, p. 254, 1925; Ferrière, *Rev. Suisse Zool.*, 34, p. 61, 1927; Mani, *Cat. Ind. Insects*, 23, p. 144, 1938; Fulmek, *Entom. Beih. Berlin-Dahl.*, 10, p. 23, 1943; Thompson, *Cat. Par. Pred. Ins. Pests*, 1, pt. 3, 1944<sup>1</sup>.

2. — *A. hilli* (Dodd et Gir.) ♂, *comb. nov.*

syn. *A. chionaspidis* var. *hilli* Dodd et Gir.

Dodd et Girault, in Dodd, *Trans. R. Soc. S. Austral.*, 41, p. 352, 1917; Mercet, *l. c.*, p. 366; Thompson, *l. c.*<sup>1</sup>.

Australie  
septentrionale:  
Darwin

Cochenille de Graminée (ap. Hill);  
*Poliaspis graminis*  
(Green)? (ap.  
Dodd et Girault).

3. — *A. emersoni* Gir. ♀

Girault, *Insec. Inscit. Mens.*, 8, p. 98, 1920; Mercet, *l. c.*

Queensland:  
Brisbane

Hôte inconnu.

4. — *A. africanaspidis* Ghesq. ♂♀

Congo belge:  
Mulungu

*Africanaspis chionaspidiformis* (Newst.)  
(= *Pinnaspis cassiae* Newst.) sur *Erythrina abyssinica*.

5. — *A. leucaspidis* Merc. ♂♀

Mercet, *l. c.*, p. 367, 4 figs; Ferrière, *l. c.*; Ceballos, *Las Tribus Him. Esp.*, p. 217, fig. 169, Madrid 1941—43; Fulmek, *l. c.*, p. 54; Thompson, *l. c.*, p. 68.

Espagne:  
Madrid,  
San Rafael

*Leucaspis pini* (Htg.)  
sur *Pinus halepensis*  
et *P. sylvestris*.

6. — *A. pini* Ferr. ♂♀

Ferrière, *Actes Soc. Helv. Sci. Nat.*, 107, p. 223, 1927; *Rev. Suisse Zool.*, 34, p. 62, fig. 5, 1927; Fulmek, *l. c.*, p. 5; Thompson, *l. c.*

Suisse:  
Sierre

*Leucaspis pini* (Htg.)  
sur *Pinus sylvestris*.

7. — *A. funicularis* (Bakk.) Ghesq. ♂♀

syn. *Hexalis funicularis* Bakk.

Bakkendorf, *Korresp. Bl. naturf. Ver. Riga*, 63, p. 86, 4 figs, 1939 (génotype de *Hexalis* in *Aphelinidae*); Ghesquière, *Ann. Bull. Soc. ent. Belg.*, 84, p. 150, 1948, (Biologie).

Lettonie:  
Kanjer-Moor  
Suède:  
Stockholm

Cochenille (?) sur des  
*Pinus*.  
*Leucaspis loewi* Colv.  
sur *Pinus sylvestris*.

<sup>1</sup> Dans son Catalogue, Thompson signale par erreur l'Espagne dans la dispersion géographique de cette espèce.

8. — *Anthemus* sp. 1

Hill, Dpt. Ext. Affairs, *Bull. North. Terr.*  
n° 13, 16 pp., Melbourne 1915.

Australie  
septentrionale:  
sin. loc.

*Pinnaaspis* minor  
(M a s k.)<sup>2</sup>. (*Hemichionaspis*) sur *Agave sisalana*.

9. — *Anthemus* sp. 2

Balachowsky, *Ann. Epiph.*, 14, p. 305,  
1928, (biologie); Fulmek, l. c., p. 52;  
Thompson, l. c., p. 66.

Algérie:  
Alger

*Lepidosaphes ampe-*  
*loidesmae* Newst.  
(*Mytilococcus*) sur  
*Ampelodesma tenax*.

## Clé des espèces

1. — Ailes antérieures dépourvues de poils discaux, ♀ long. ? ..... *emersoni*  
Ailes antérieures ± densément garnies de poils discaux ..... 2.
2. — Ailes postérieures glabres; funicule ♀ de 5 articles ..... 3.  
Ailes postérieures avec 1 ou 2 lignes de poils discaux; funicule ♀ de 5 ou  
6 articles ..... 4.
3. — Antennes ♀ à articles du funicule un peu plus longs que larges, sauf le  
dernier subcarré; massue plus grande que les 3 articles précédents; antennes  
♂ ♀ un peu plus longues que la moitié du corps. Abdomen ♂ ♀ plus court que  
le thorax. Portion distale des ailes antérieures à bords parallèles. ♀ 0,63 mm.,  
♂ 0,68 mm. .... *africaspidis*  
Antennes ♀ à articles du funicule un peu plus larges que longs; massue presque  
aussi longue que les 5 articles du funicule. Abdomen ♀ plus long que le  
thorax. Portion distale des ailes antérieures à bords convergents.  
♀ 0,54 mm. .... *hilli*
4. — Ailes postérieures avec 1 ligne de poils discaux. Antennes ♀ à funicule de  
5 articles subcylindriques; massue ovale plus grande que les 3 articles pré-  
cédents. Abdomen ♂ ♀ plus long que le thorax. Portion distale des ailes  
antérieures à bords convergents. ♀ ♂ 0,536 mm. .... *chionaspidis*  
Ailes postérieures avec 2 lignes de poils discaux. Antennes ♀ à articles du  
funicule nettement plus longs que larges ..... 5.
5. — Portion distale des ailes antérieures à bords convergents. Antennes ♂ ♀ plus  
longues que les 4/5 du corps; antennes ♀ à funicule de 6 articles, le dernier  
subcarré; massue aussi longue que les 4 articles précédents. Abdomen plus  
court que tête et thorax réunis. ♀ 0,55 mm. ♂ 0,61 mm. .... *pini*  
Portion distale des ailes antérieures à bords parallèles. Antennes ♀ à dernier  
article du funicule cylindrique; massue un peu plus longue que les 3 articles  
précédents ..... 6.

<sup>2</sup> Si les exemplaires récoltés par Hill ont été bien identifiés et comparés au type qui est australien, ils n'appartiennent certainement pas au gn. (*Hemichionaspis*) = *Pinnaaspis*, mais à un genre à définir (ap. Hall 1946 et Ferris 1947). Sinon, ils se rapportent probablement à *P. strachani* (COOL), espèce pantropicale et polyphage qui est déjà signalée de Nouvelle-Guinée. — *H. minor* auct. est une espèce omnibus à diviser entre plusieurs *Pinnaaspis* dont *P. strachani* et *P. aspidistae* sont les plus répandus.

6. — Antennes un peu plus longues que la  $1/2$  du corps; funicule ♀ de 6 articles.  
Abdomen ♀ subégal à tête et thorax réunis. ♀ 0,75 mm. ♂ 0,50 à 0,65 mm. .... *funicularis*  
Antennes plus longues que les  $2/3$  du corps; funicule ♀ de 5 articles.  
Abdomen ♀ nettement plus long que tête et thorax réunis. ♀ 0,635 mm., ♂ 0,71 mm. .... *leucaspidis*
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## ZUR ENTSTEHUNG DER QUERCYFOSSILIEN

Von Ed. Handschin

An der Grenze des französischen Zentralplateau liegen in Klüfte und Taschen des Lias eingebettet die Phosphoritablagerungen des Quercy. Sie sind bedeutend jüngern Datums als das Gestein in welches sie eingelagert sind. Die zeitliche Datierung ist an Hand der vielen vorhandenen Säugetierreste vorgenommen worden. Nach ihnen wird das Quercy dem Bathonien bis zum Stampien zugewiesen, ausserdem sind auch Reste pliocäner Säuger nachgewiesen worden.

In diesen Phosphoriten fand sich nun auch eine reiche Insektenfauna vor, deren Altersbestimmung aber nicht ohne weiteres möglich ist, da sie mit den Faunen des stratifizierten Tertiärs nicht ohne weiteres vergleichbar ist.

Insektenreste sind im allgemeinen fossil recht selten. Sie liefern in der Regel keine eigentlichen Leitfossilien oder spielen bei der Altersbestimmung der Schichten nur eine ganz untergeordnete Rolle. Mit dem Tertiär scheint übrigens schon Entwicklung soweit abgeschlossen zu sein, dass wesentliche Veränderungen kaum mehr zu konstatieren sind und da die Insekten überdies als sehr konservative Gesellschaft bezeichnet werden müssen, so ist es begreiflich, dass auch den Quercyinsekten bis jetzt wenig Beachtung geschenkt worden ist. *Filhol*, *Gervais* und *Thevenin*, welch letzterem wir eine umfassende Monographie des Quercy verdanken, erwähnen nebenbei ihre Anwesenheit. Einzig *Flach* beschreibt einige Käfer eingehender. Dieses Fehlen eingehender Dokumentation bei dem wunderbaren Erhaltungsgrad der Quercyfossilien mutet bei der Bearbeitung erstaunlich an. Während nämlich sonst von fossilen Insekten blos Abdrücke vorhanden sind, sind sie hier vollständig plastisch erhalten geblieben. Dieser Erhaltungszustand, der übrigens auch bei Fröschen sich zeigt, hat verschiedentlich zu Diskussionen über die Entstehung der Fossilien und des Quercy Anlass gegeben.

*Thevenin* und *Filhol* sind der Ansicht, dass die Tiere von feinem Lehm eingehüllt worden sind. Beim Austrocknen haben sie sich dann in ihrer Hülle zersetzt, d. h. sie sind verwest und die dadurch entstandene Höhlung wurde durch eindringende Phosphate oder von Lehm ausgefüllt. *Gèze* hat noch 1938 sich mit der Entstehung der Ablagerungen vom Standpunkte des Geologen und Technikers beschäftigt und alle Möglichkeiten zusammengestellt, welche zur Bildung der Phosphatlagerstätten führen konnten. Da in der Umgebung der Schloten sich heute keine Thermen nachweisen lassen, nimmt er an, dass die Phosphate durch Anreicherung in den Schloten aus den sich dort häufenden Kadavern gebildet hätten. Die Mitbeteiligung heisser Quellen weist er völlig ab.

Es erhebt sich nun für uns die Frage, ob nicht doch die Insektenreste uns etwas zur Entstehungsgeschichte des Quercy sagen könnten, denn gerade von entomologischer Seite verdienen sie sicher eine spezielle Würdigung. Ausser den 2 von *Flach* erwähnten Silphiden, liegen nur sehr oberflächliche Meldungen vor. *Thevenin* spricht von einem Acridier, der sich in den Sammlungen von Montauban befindet und *Gervais* berichtet von einem Dynastiden, der einmal in einer Sitzung in Paris gezeigt worden ist und für welchen der Name *Pseudopentodon blanchardi* vorgeschlagen wird. Leider ist eine genau Beschreibung aber nie erfolgt. Ebenso ist die Puppe einer „*Triphaena*“ das Gelege einer Blattide sowie grosse Stücke, ähnlich Cicadenlarven (?) nur den Namen nach besonders häufig erwähnt. *Brogniart* definiert nach den unter den Fossilien

anwesenden Fliegenlarven, Silphiden und Myriopoden die Insektenfauna des Quercy als obscuricol oder cadavericol. Wir können ihm im letztern voll und ganz beipflichten, sind doch gerade die kleinen Fliegentönnchen zu hunderten vorhanden. Nachdem ich vorerst die Materialien aus dem Quercy des Museums von Basel bearbeitet hatte, war es mir möglich, die in Paris und Montauban liegenden Sammlungen zu einer Revision zu erhalten. So ist es mir heute möglich eine vorläufige Uebersicht über die Faunula zu geben. Bis heute haben die Phosphorite des Quercy folgende Arthropoden geliefert:

- 3 Myriopoden (Diplopoden)
- 1 Opilionide
- 4 Orthopteren (incl. Gelege)
- 10 Coleopteren (Carabiden, Silphiden, Aphodiden,  
?Dynastiden, Cerambyciden-Curculioniden)
- 3 Fliegen (Larventypen von 3 Phoriden)
- 1 Hymenoptere (parasitisch)

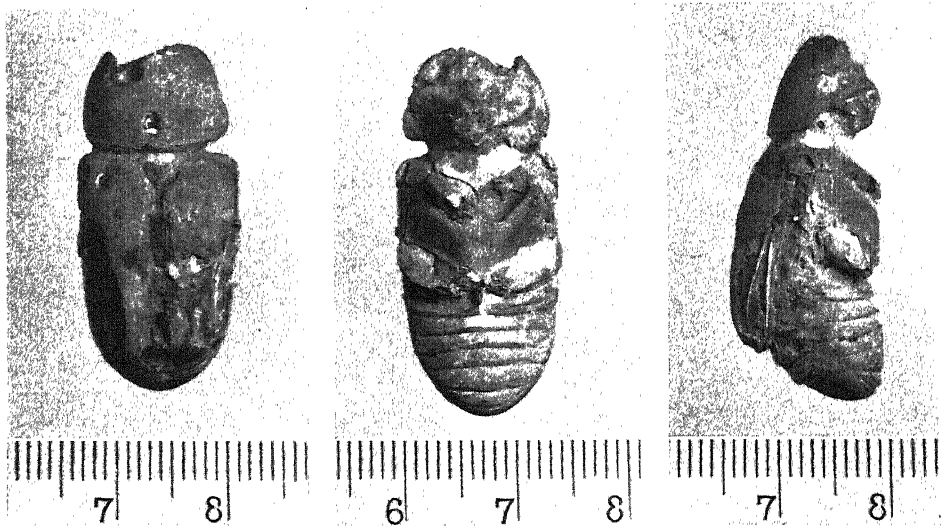


Fig. 1. „*Pseudopantodon blanchardi*“ des Museums von Paris  
von oben, unten und von der Seite.

Von diesen 22 Formen leben 10 auf Cadavern, die übrigen sind als Bodenformen zu bezeichnen, die aber nicht ausgesprochen Dunkeltiere sind. (Carabiden, Cerambyciden-Dorcadion, Myriopoden, Blattiden, Orthopteren) Auffallend ist, dass eine der Myriopoden in der Gattung *Silvestria* heute in der Gegend noch einen nächsten Verwandten besitzt, dass eine *Onthophilus*-art den unsrigen noch sehr ähnlich sieht, mit andern Worten, dass sich die Quercyfauna durchaus mit der heute an ähnlichen Lokalitäten lebenden vergleichen darf. Sicher gehen wir auch nicht fehl, wenn wir die Bodenfauna als normale Begleitfauna bezeichnen. Die eigentliche Fauna ist rein cadavericol. Fliegentönnchen der Phoriden, also der eigentlichen Leichenfliegen und Aaskäfer, machen weitaus die grösste Menge der aufgefundenen Formen aus.

Leider ist nun auch beim Sammeln der Fossilien gar nicht auf die gegenseitige Lage der Fossilien oder die relative Dichte der Funde in Bezug auf grössere Fundstück geachtet worden. Der gewerbsmässige Abbau der Phosphorite in den Jahren 1870—1900 liess eine solche Hebung der Funde nicht zu. Sie wurden dem Zufall überlassen. Die Funde wurden auch meist gewerbsmässig vertrieben (durch den Händler *Rossignol*). So wird wohl kaum mehr eine Rekonstruktion der Thanatocoenose möglich sein, was um so bedauerlicher ist, als heute der Abbau in den Gruben eingestellt ist.

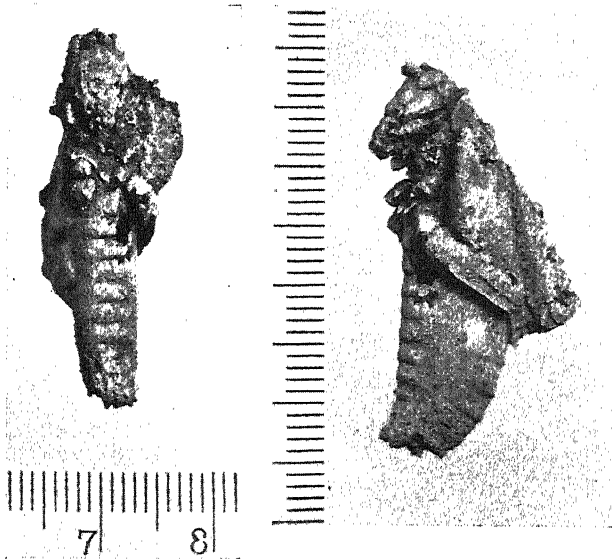


Fig. 2. Der „Acridier“  
von Montauban,  
von der Seite und von  
unten.

Ohne hier die spezielle ökologisch-biologische Analyse der Zusammensetzung der Quercyinsekten weiter zu verfolgen, möchte ich doch auf den Erhaltungszustand noch etwas näher eintreten. Bei einem Teil der Puparien, die in sehr grosser Menge vorhanden sind, ist die äussere Chitinhülle teilweise abgesprungen. Im Innern der Hülle befindet sich nun nicht, wie dies nach den Voraussetzungen *Thévenins* zu erwarten wäre einfach ein Phosphorit-oder Boluskern, sondern mehr oder weniger transparent die eigentliche Puppe der Fliegen in allen Details, so wie sie bei sorgfältiger Präparierung an lebenden Puppen ebenfalls frei gelegt werden können. Die Erhaltung der Beine, Rüssel und Kopfpartien und der Flügel ist so vollkommen, dass der Versuch nahe lag, Schliffserien durch solche Puppen anzulegen, um so einen Einblick in die Anatomie der Quercy-Phoriden zu erhalten. Die Resultate waren überraschend, zeigten doch die oft dicken Schliffe noch erstaunliche Details der Larvenstruktur.

Im Längsschliff ist nicht bloss der ganze Aufbau des Fliegendarmes sichtbar, sondern es zeigen sich die feinen Einzelheiten des Fliegenrüssels mit den Pseudotracheen, die Antennenbeborstung etc. während auf einem Querschliff der Bau des Fazettenauges und offenbar das Gehirn der Fliege erhalten geblieben ist. In einem Tönnchen fand sich nicht nur der Körper der Fliege, sondern ein eingeschlossener Parasit vor. Dass es sich bei der eingeschlossenen Masse nicht um einfaches Füllmaterial aus Phosphoritkristallen handeln kann beweist die Betrachtung unter dem Polarisationsmikroskop.

In diesem zeigt sich der Phosphorit als schwarze Masse mit eigenartig schaliger Struktur von hellen Linien, während der Inhalt der Insektenkörper einheitlich schwarzbraun erscheint.

Die lebende Fliegenpuppe ist nun recht hinfällig. Störungen in der Entwicklung oder schon leichte Verletzungen und Quetschungen führen zum Absterben und damit zur völligen Liquifizierung des Inhaltes eines Tönnchens. Wenn nun aber der ganze Inhalt einer Puppe fossil erhalten ist, bedeutet dies, dass ihr Inhalt auf irgend eine Weise abgetötet, fixiert und konserviert wurde, und zwar muss dieser Prozess so gründlich erfolgt sein, dass eine Fossilisierung nachher möglich wurde. Beim Fixieren von Puppentönnchen zu anatomischen Zwecken werden dieselben an einer Stelle geöffnet, dass die Konservierungs- und Fixierungsflüssigkeiten eindringen können. Dies muss auch hier erfolgt sein, denn die Hohlräume der Puppenhüllen sind mit Phosphoriten ausgefüllt. Aus dem Erhaltungszustand des Puppeninhaltes müssen wir annehmen, dass eine rasche Fixierung durch eine heisse Lösung erfolgt ist. So ist die Abtötung der Puppen erklärlich. Die in heissem Wasser aus der Umgebung gelösten P.-Salze sind dann in die Puppe eingedrungen und haben sie fixiert und später zur Fossilisierung geführt, ohne dass sich der Inhalt der Puppe weiter zersetzt haben konnte. Auf keinen Fall kann es sich um ein bloßes Ausfüllen von Körperhöhlungen handeln, oder darum, dass einfach die äussere Hülle als Wandung in der Einschlussmasse erhalten blieb, wie dies z. B. bei den Bernstein Insekten der Fall ist. Hier ist der Leibesinhalt mit konserviert worden. In ähnlicher Weise wie die Insekten sind auch andere Tiere eingeschlossen worden. Wir besitzen den Körper einer Opilionide und verschiedene Raupen, die in voller Form erhalten sind und bei denen sogar Details der Hautstruktur wahrnehmbar sind. Es würde sich sicher auch lohnen, die als ganze Körper im Quercy eingeschlossenen Frösche einer erneuten Untersuchung zu unterziehen.

Mit dieser Feststellung aber dürfte von biologischer Seite aus der Beweis erbracht sein, dass bei der Entstehung der Quercyfossilien heisse Lösungen eine Rolle gespielt haben müssen, denn ohne solche wäre ein derartiger Erhaltungszustand weicher Insekten absolut undenkbar.

Insgesamt betrachtet stellen die Quercyinsekten ja nur einen verschwindend kleinen Teil der Tertiärinsekten dar. Die längst bekannten Faunen von Oeningen und Radoboj, von Aix en Provence und Florissant, die Faunen der Kalibergwerke von Wittenbach i/Elsass, Brunnstatt und aus dem Bernstein stellen sie mit ihrem Reichtum weit in den Schatten. Ueberall handelt es sich aber um spezielles, an besonders eigenartige Biocoenen gebundenes Vorkommen, das auch hier im Quercy doch eine ganz besondere Eigenart aufweist, die Bindung an Kadaver und den Erdhoben, d. h. an die Wandungen der Phosphoritschlote. So mag uns doch die kleine Teilfauna einen Einblick in das Leben ferner Zeiten vermitteln, ein Bild aus sicher durch alle Funde, die heute noch in Schränken der Museen vergraben liegen bedeutend erweitert werden kann.

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## HOSTPLANTS AND APHID CLASSIFICATION

By D. Hille Ris Lambers

The majority of aphids are monophagous or oligophagous. Only few are almost pantophagous, but even in these the number of plants on which hibernation as eggs is possible is generally very small.

The non-monophagous species in a temperate climate can be divided in two biological groups. In the first group the species complete their cycle from egg to egg on one group of plants, in the second, the migrating aphids, two plants or two groups of plants each serve as habitat for a part of the cycle.

In the non-migrating oligophagous aphids with a complete cyclus each species lives only on a number of closely related plants. There are only a few exceptions to this rule. So *Brevicoryne brassicae* L., a pest of Cruciferae, also infests *Tropaeolum* in summer and in this resembles *Pieris* spp.; *Acyrtosiphon pisum* Harris, noxious on herbaceous Leguminosae, in summer is rather common on *Capsella*; *Aphis pomi* Geer, which generally lives only on *Pirus* and related Rosaceae, in summer may successfully colonize *Sedum Kamschaticum*.

Though we know little or nothing about the tie which binds the parasite to the host, we may assume that various factors play a rôle, independently or together. Among those factors chemical composition, the quality of the surface and the anatomical structure probably are important. Botanists agree that several of these qualities are correlated with systematic relationship in plants. And so the mentioned exceptions seem to confirm the general rule that oligophagous aphids live on closely interrelated hosts.

A quite different case is found in migrating aphids, aphids which need two species, or two groups of hostplants for the completing of their cycle. The hibernating eggs are always laid on a deciduous tree or shrub.<sup>1</sup> Here two or more generations of viviparous aphids develop, of which the 2nd or 3rd is more or less completely alate. The alate forms fly away to another hostplant on which only vivipary occurs and from this hostplant eventually one or two morphs return to the hostplant on which hibernation as eggs occurs.

The phenomenon, apparently suspected by Bonnet, 1745, in *Aphis fabae* Scop., was described by Walker in 1847. Often Lichtenstein is credited with the discovery of migration in aphids, because Walker mixed up normal polyphagism and migration in his paper of 1847. But in a note on *Phorodon humuli* Schrank, published one year later, Walker gives the very "modern" advice to control the Hop-fly by destroying the winter-eggs on *Prunus spinosa* and this undoubtedly shows that he understood aphid-migration very well.

<sup>1</sup> Two exceptions have been published, both by E. M. Patch. She writes that both *Myzus pseudosolani* Theob. (= *Aulacorthum solani* Kltb.) and *Aphis gossypii* Glover migrate and hibernate as eggs on *Digitalis* and *Sedum purpureum*, respectively. Since she describes the males of the species as being apterous, true migration is excluded, because in the group of aphids, to which the species belong the males are born on the secondary host and migrate to the primary host, if the species migrates. The solution in the case of *Aulacorthum solani* (Kltb.) is, that this species can hibernate as eggs on a great many different plants. And *Aphis gossypii* Glover may have been confused with the very similar *Aphis sedi* Kltb., which permanently lives on Crassulaceae (*Sedum*, *Sempervivum*) and which has apterous males.

We will use the term *primary host* for that plant on which hibernation as eggs occurs and the name *secondary host* for the plant on which the purely viviparous part of the cycle is performed. The much-used terms "winterhost" and "summerhost" are less satisfactory. For in some species the cycle is completed in two years, e.g. in certain *Hormaphis* species where the eggs hibernate on one plant and certain viviparous forms hibernate on another plant.

A study of the hosts of migrating species reveals a very curious fact which so far has received no comment. In any species of which migration is known it appears that primary and secondary hostplants are very much different, in fact not in the least related. Any list of migrating aphids with their hostplants shows this clearly and without exceptions.

Though it is impossible to find an other explanation than polyphagism for the very origin of migration in aphids it is rather baffling, that the final result should be an alternation between two plants, which systematically stand so far apart. One would from polyphagism except an evolution towards specialisation on a set of closely interrelated plants.

Very generally one finds that related species of aphids also live on related species of plants. So the large Cosmopolitan genus *Dactynotus* Raf. lives almost exclusively on Compositae and Campanulaceae; *Brevicoryne* Das (+*Lipaphis* Mordvilko) on Cruciferae, a group of *Aphis* species related to *Aphis jacobaeae* Schrank only on certain Compositae, etc. All these groups of aphids do not migrate.

In the migrating species it is more difficult to find such a rule, for on principle each species includes two non-related plants in its food. If, however, only the primary hostplants are considered, it appears that here also the rule holds to a large extent. So all *Cavariella* species of the world hibernate as eggs on *Salix* species while in summer Umbelliferae or the related Araliaceae are chosen. *Pemphigus* species migrate from *Populus* to a large variety of secondary hosts and so do *Eriosoma* and related genera from *Ulmus*, *Forda* and relatives from *Pistacia*, etc. The primary hostplants of related species are apparently also closely related, though there are some exceptions, as we will see later.

The question which of the two hostplants of a migrating species in the more original host still wants an answer. In migrating aphids the first generation on the primary host very often makes typical galls, which suggests a very long association between the aphid and his host. True, closed galls are never found on secondary hostplants.

In many migrating species morphologically very similar species are found on the secondary hostplants, which, however, do not migrate. So in *Metopolophium* Mordv. the species *M. dirhodum* Wlk. migrates from *Rosa* to Gramineae; but the nearly related *M. tenerum* H. R. L., *M. albidum* H. R. L., *M. festucae* (Theob.) and *M. friscum* H. R. L. complete their cycle on Gramineae. *Capitophorus elaeagni* (Del Guercio) migrates from Elaeagnaceae to tubuliflorous Compositae, where two other *Capitophorus* species live permanently. We suppose that the related species, which live permanently on the secondary hostplants of the migrating species are derived from the migrating species. There is a morphological relation between these "secondary" species and the "primary" species. Migrating species are generally strongly polymorphic; particularly the fundatrix, but also often also the oviparae are very different from the forms developing on the secondary hostplant; though the fundatrix often demonstrates its long association with the primary hostplant by making complicated galls, real galls are never made on the secondary hostplant. In the "secondary" non-migrating species all

the forms forming the annual cycle are mutually very similar, and they all resemble only those forms of the corresponding migrating species which are born on the secondary hostplant of the migrating species.

The apparent strong specialisation of certain forms on the primary hostplant in migrating species as compared to the absence of such a specialisation in the "secondary" species seems to suggest that the primary hostplant really is the more original hostplant, so that the term "primary" for this hostplant is correct.

Summing up, we find that in non-migrating aphids related species live on mutually related hostplants, and that also in migrating aphids related species live on related hostplants, if only the secondary hostplants are left out of consideration.

What may we conclude from this? Two explanations are possible. If an oligophagous aphid has a number of mutually related hostplants, similar in those qualities which are essential for the existence of the aphid, the developing of subspecies and further speciation may be expected sooner on these hostplants than on any other hostplant. The final result would be that which we see at present. The other explanation is, that the hostplant of a monophagous or one of the hostplants of an oligophagous aphid begins to form subspecies and eventually becomes the ancestor of a genus or larger group of plants. It might be reasonably expected that the aphid living on the ancestor-hostplant would follow the evolution of this plant and eventually form a number of subspecies, later species on the offspring of that hostplant. The latter case may be called parallelous evolution.

Since the final result of either way of evolution would be quite the same, it is very difficult to decide what has happened in the past. Studies like these have been made for a number of animal parasites and their animal hosts, and generally the conclusion was that when related parasites live on related hosts, parasite and host show parallelous evolution, vide the summary in Metcalf, 1929. Cases as found by Kellogg, in which predator and prey have similar Mallophaga, and the case of *Brevicoryne brassicae* L., which accepts as food *Tropaeolum*, an imported plant, not closely related to its normal hostplants, Cruciferae, should offer a distinct warning against generalisation.

The following example, however, shows that parallel evolution really occurs, as might be expected. On the plant-order of the Rosaceae a great many different aphid genera live permanently, or temporarily with Rosaceae as primary hostplants. Nearly all these genera seem to be closely interrelated, and they all can be arranged in such a way that a family-tree is the result. The stem of the tree is formed by *Anuraphis* del Guercio, a rather primitive genus with short siphunculi and a cauda which still looks what it is: the anal tergite, while the finest branches are formed by genera like *Macrosiphum* Pass. and *Acyrtosiphon* Mordv. in which the anal tergite has become a long tail and in which the siphunculi have reached a very great length.

If the hostplants of these genera on Rosaceae are studied, it appears, that the more primitive aphid genera live only on the more primitive Rosaceae. The less original each genus is, the more subfamilies of Rosaceae are among its hostplants. The more primitive aphid genera on Rosaceae cause very typical pseudo-galls, the more recent no reaction at all. All this seems to suggest that the evolution of these aphids together with their hosts the Rosaceae can still be read in the living aphids and their hostplants. The number of aphid genera which in the present case are involved is large; the phenomenon can therefore hardly be accidental and seems to offer excellent proof, that parallel evolutionary development of parasites and hosts occurs.

The rarity of similar phenomena in aphids is instructive; only on Caprifoliaceae a long evolutionary series of aphid genera could be found, but so far nowhere else. This may suggest that many aphids have not yet lived very long on their present hosts. We saw this already in the "secondary" species split of from a migrating species on its secondary hostplant, but also the primary hosts of migrating aphids may be rather recently acquired. The latter conclusion is reached by considerations such as the following: on Elaeagnaceae in the Northern Hemisphere live many Capitophorus species which migrate to various hosts in summer. No aphid genus is known from this plant-family which possibly could be its ancestor. But a morphologically closely related genus, Pentatrichopus Börner, lives on Rosaceae and distinctly forms part of the family-tree of aphid genera on Rosaceae. Now we want to suggest that Capitophorus v.d. Goot had few or no ancestors on Elaeagnaceae, but came there in more or less its present status from elsewhere, e.g. from Rosaceae. The same holds for Cryptomyzus Oestl. on Ribes and Corylobium Mordv. or Corylus.

Another example of "recent" associations between primary host and parasite is offered by Prociphilus species. Prociphilus Koch is a member of the Pemphigids, a group of genera which show the strongest possible bonds with Populus, where they usually make complicated galls.

European Prociphilus hibernate as eggs on Crataegus, Fraxinus and Lonicera and migrate to the roots of Pinus, Abies (and Tsuga) and Picea respectively. Migration to roots of Coniferae is found in the closely related Pachypappa Koch on Populus. The data seem to suggest that the Prociphilus species from Crataegus, Fraxinus and Lonicera came there from Populus, and at a time when the migration between Populus and roots of Coniferae already existed.

Aphids offer a wide field for speculations. But these speculations may be of practical use for the taxonomist. In several cases the study of hostplants may help in the classification. Börner uses the position of an often minute tubercle on the VIIth abd. tergite to separate Aphis L. and related genera from Rhopalosiphum Koch and related genera. This looks like hairsplitting, but the final result is fascinating if the hostplants are taken into consideration. The large group of Aphis-like aphids in which this tubercle is placed slightly dorsally in relation to the nearest stigma appear to be aphids which either migrate from Rosaceae to grasses and sedges or live permanently on one of these groups of hostplants. And also in other minute morphological characters these aphids distinguish themselves from the Aphis-like aphids with a more ventral tubercle on the VIIth abd. tergite, of which none lives on grasses and sedges and only a few on Rosaceae.

We certainly would not have attached so much value to the position of this tubercle if not hostplant studies had shown the importance. The aphids with "dorsal" marginal tubercle on the VIIth abd. segment are evidently a natural group, which originated on Rosaceae and which from there colonized Gramineae and related plants. It is easy to elaborate this theme, but it will already be clear from the above considerations, that the study of hostplants and their mutual relationship may be of considerable importance in the study of aphids. And in future also botanists may gain by the study of plant parasites, for often parasites are excellent micro-indicators for the relationship of plants.

*Postscript.* In this discussion Adelgidae and Phylloxeridae are not considered to be aphids.

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## GEDANKEN ZU GEGENSEITIGEN TAUSCHVERBINDUNGEN DER MUSEEN

Von *Tahvo Kontuniemi*

Jeder Systematiker ist beim Bestimmen der Arten wohl sicherlich zu der Erkenntnis gekommen, wie viel Mühe das einwandfreie Gelingen öfters fordert, wenn man gezwungen ist, sich nur an die vorhandenen Bestimmungstabellen zu halten. Dies betrifft namentlich die kritischen Artengruppen, die oft einander dermassen ähnliche nahe-stehende Arten umfassen, dass eine wörtliche Bezeichnung der Merkmale schwierig wird, und man sich vielfach genötigt sieht, zu relativen Merkmalen zu greifen. Auch beigefügte Abbildungen, die ausserdem leider gar zu oft fehlen, liefern nicht immer eine klare Entscheidung, so viel sie bei sorgfältiger Ausführung dem Benutzer auch helfen.

Das beste und sicherste Ergebnis ist dann zu erzielen, wenn man Zugang zu Vergleichsexemplaren von den jeweils in Frage stehenden Arten hat. Aus diesem Grunde hat man den Typexemplaren immer grössere Beachtung zu schenken begonnen, und so findet man denn auch heute schon im Zusammenhang mit der Beschreibung von neuen Arten stets auch den Aufbewahrungsort des betreffenden Typexemplars angegeben. Dieses Exemplar ist besonders gemerkt, mit einem Typenzettel und gewöhnlich auch mit einer Typennummer versehen, aus denen unzweideutig zu entnehmen ist, welches Exemplar der betreffenden Diagnose zugrundegelegt hat. Sofern genügend Material vorhanden, pflegt man alle gleichzeitig untersuchten Stücke der Holotype als Paratypen nebenzustellen, ein Umstand, der allerdings bisweilen zu Wirrnissen geführt hat, wenn es sich um sehr nahestehende und also einander weitgehend ähnliche, aber einstweilen nicht eingehender untersuchte Arten gehandelt hat. Es hat sich später herausstellen können, dass Holotype und Paratype gar nicht der gleichen Art angehören. Doch auch die Beschaffung jener Typen und Paratypen für die vergleichende Untersuchung ist keineswegs immer leicht. Und es kann in Frage gestellt werden, ob sich ihre Versendung oft über weite Strecken zumal in jenen unruhigen Zeiten überhaupt empfiehlt. Auf jeden Fall ist damit ein bedeutender Zeitaufwand verbunden.

Um jenen Schwierigkeiten wenigstens teilweise zu entgehen, habe ich mir nun gedacht, die Gründung von Insektenexsikkaten vorzuschlagen, entsprechend denjenigen, wie sie unter den Botanikern schon längst bekannt sind. Dort geht man ja so vor, dass man an einem gegebenen Ort gleichzeitig zahlreiche Proben einer bestimmten Art einsammelt und sie dann mit den nötigen Vermerken versehen und zu Exsikkatensammlungen vereinigt an Institute und andere Empfänger in aller Welt versendet. Die Vorteile dieses Verfahrens liegen ja offen auf der Hand und bedürfen daher hier keiner weiteren Erörterung. Ich möchte mich jedoch für eine noch sorgfältigere Auswahl der Exemplare für ein solches Insektenexsikkat aussprechen, insofern nämlich, als die dem Exsikkat einzuverleibenden Exemplare durch Aufzucht der Eier eines bestimmten Weibchens gewonnen sein sollten. Dies lässt sich leicht zumal in betreff der phytophagen Insekten erzielen. Ganz unumgänglich wäre ja eine solche Aufzucht „ex ovo“ freilich nicht, ihre Vorteile sind aber unleugbar. Besonders wünschenswert wäre eine unverzügliche Distribution aller neuen Arten, auch der bei Artrevisionen durch Aufspaltung alter entstandenen, durch das Exsikkat.

Mich persönlich interessieren die Sägewespen am meisten, und es ist der Plan gefasst worden, allmählich durch Vermittlung des Zoologischen Museums der Universität Helsinki eine in kleinen Portionen geschehende Versendung des zu gründenden Sägewespenexsikkats an die grössten Museen des holarktischen Gebietes in Gang zu bringen. Der Sendung wird ein in lateinischer Sprache abgefasster Ausweis beigegeben, dessen Muster Sie hier sehen:

„SYMPHYTA FENNICA EXSICCATA.

N:o 1. *Macrophya sanguinolenta* Gmel. ♀ ♂  
Planta nutrimenti: *Veronica longifolia* L.  
Ex ovo auctae 15. VI. 1947—10. VI. 1948.  
Locus: Uusimaa Pernaja.  
Legit et auxit Tahvo Kontuniemi.

N:o 2. — — — —.”

Da ist zunächst die Nummer, die auch auf dem unter dem betreffenden Exemplar angebrachten, die Aufschrift „Symphyta Fennica Exsiccata” tragenden Zettel vermerkt ist; zweitens der Name des Insekts nebst Namengeber und Geschlechtsangabe; drittens auf besonderer Zeile die Nahrungspflanze; viertens ebenfalls auf eigener Zeile die Zeitangabe der Aufzucht bzw. der Zeitpunkt des Einsammelns; fünftens und sechstens schliesslich Fundort und Name des Sammlers.

Ich wäre den hier anwesenden Herren Museumpräfekten sehr verbunden, wenn sie mir schon im Verlauf dieser Tagung mitteilen wollten, ob sie gewillt sind, mit uns in den obenangedeuteten Tauschverkehr einzutreten.

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## LES LITOPUS (Col. Cerambycidae)

Par P. Lepesme

Les *Litopus* sont des Callichromines assez difficiles à séparer des *Hospes* et maints auteurs ont hésité ou se sont trompés en les classant. C'est ainsi que le *Litopus superbis* Lmr. de la Côte d'Ivoire doit venir se ranger dans les *Hospes*, de même que le *L. virens* Jord. considéré par Schmidt<sup>1</sup> comme une sous-espèce de *superbis* et qui, en réalité, est une bonne espèce; par contre, la sous-espèce *auricollis* Schmidt de *superbis* qui est, elle aussi, une espèce valable, est bien un *Litopus*. Je réintroduis également dans ce genre les *L. semiopacus* Frm. et *helymaeoides* Auriv. et décris ci-dessous trois nouvelles espèces.

Les *Litopus* semblent propres à l'Afrique méridionale et orientale, bien que le *L. auricollis* Schmidt, espèce assez aberrante d'ailleurs par sa livrée, soit décrit de la Guinée espagnole. Les *Hospes*, se rencontrent en Afrique occidentale, centrale et orientale, mais ne descendent pas en Afrique du Sud.

On séparera les deux genres de la manière suivante :

1. Tibias postérieurs courbés, leur bord externe toujours plus ou moins convexe, l'interne concave. Tarses postérieurs courts, le premier article au plus égal aux trois autres réunis, griffes comprises. Pronotum à "cou" bien tranché, au moins latéralement ..... *Litopus*.
- Tibias postérieurs subdroits, leurs bords externe et interne tous deux concaves. Tarses postérieurs longs, le premier article au moins égal aux trois autres réunis, griffes comprises. Pronotum progressivement rétréci sur les côtes, du milieu au bord apical, sans "cou" bien tranché latéralement ..... *Hospes*.

Les différentes espèces de *Litopus* pouvant à leur tour être déterminées à l'aide des tableaux suivants :

## Tableau des ♂♂

1. Tous les fémurs entièrement bleu-violacé. Tête violet pourpre *auricollis* Schmidt.
- Les fémurs brun-rouge clair, au moins à la base, la massue des postérieurs entièrement ou en grande partie verte. Tête verte comme le reste du corps .... 2.
2. Épisternes prothoraciques remontant sur le pronotum sous la forme de bourrelets superficiels en forme de croissant très densément et très finement ponctués, mats, bien visibles de dessus ..... 3.
- Épisternes prothoraciques ne remontant pas sur le dessus du pronotum ..... 5.
- 3.. Région discale du pronotum limitée par les bourrelets épisterniques petite, atteignant seulement le tiers de sa largeur dans sa plus grande dimension, finement chagrinée et mate ..... *latipes* F.
- Région discale du pronotum limitée par les bourrelets épisterniques grande, finement ou grossièrement ponctuée et luisante ..... 4.
4. Bourrelets épisterniques rapprochés en avant, se rejoignant même parfois; ponctuation discale très grossière ..... *geniculatus* Har.
- Bourrelets épisterniques largement distants en avant; ponctuation discale fine, très éparse au milieu ..... *Neavei*, n. sp.

<sup>1</sup> Arch. Naturg., LXXXVIII, A, 6, p. 61, 1922.

5. Disque du pronotum couvert de denses rides vermiculées. Élytres courts, moins de deux fois aussi longs que la tête et le pronotum réunis ..... *reticulatus*, *n. sp.*
- Disque du pronotum finement ou grossièrement ponctué. Élytres de longueur normale, plus de deux fois aussi longs que la tête et le pronotum réunis ..... 6.
6. Disque du pronotum uni, lisse et luisant, avec seulement de très fins points épars ..... *aequabilis* Kolbe.
- Disque du pronotum densément et assez grossièrement ou très grossièrement ponctué ..... 7.
7. Côtes du pronotum sans bande de dense pubescence argentée ..... *Halli*, *n. sp.*
- Côtes du pronotum garnis d'une bande de dense pubescence argentée ..... 8.
8. Disque du pronotum très grossièrement ponctué, même au milieu, les points larges, peu profonds, subcontigus ..... *helymaeoides* Auriv.
- Disque du pronotum non très grossièrement ponctué, avec une strie médiane lisse, luisante, très nette ..... *argentatus* Schmidt.

*Tableau des ♀♀*

1. Tous les fémurs entièrement bleu-violacé. Tête violet pourpre *auricollis* Schmidt.
- Les fémurs brun-rouge clair au moins à la base, la massue des postérieurs entièrement ou en grande partie verte. Tête verte comme le reste du corps ..... 2.
2. Côtes du pronotum sans bande de dense pubescence argentée ..... 3.
- Côtes du pronotum garnis d'une bande de dense pubescence argentée ..... 7.
3. Disque du pronotum avec deux larges plages finement chagrinées, séparées par une étroite ligne joignant une région basale et une région apicale à fine et dense ponctuation ridée-réticulée ..... *latipes* F.
- Disque du pronotum sans plages chagrinées bien délimitées ..... 4.
4. Pronotum couvert de très gros points arrondis peu profonds et subcontigus ..... *Halli*, *n. sp.*
- Pronotum sans très gros points arrondis subcontigus ..... 5.
5. Disque du pronotum uni, lisse et luisant, avec seulement de très fins points épars ..... *aequabilis* Kolbe.
- Disque du pronotum grossièrement, irrégulièrement et assez densément ponctué .. 6.
6. Pronotum presque aussi large devant d'échancrure apicale qu'en son milieu, ses côtés pourvus d'un fort bourrelet tronqué droit en avant ..... *semiopacus* Frm.
- Pronotum régulièrement et assez rapidement rétréci de son milieu à l'échancrure apicale ..... *geniculatus* Har.
7. Disque du pronotum très grossièrement ponctué, même au milieu, les points larges, peu profonds, subcontigus ..... *helymaeoides* Auriv.
- Disque du pronotum non très grossièrement ponctué, avec une strie médiane lisse, luisante, très nette ..... *argentatus* Schmidt.

1. *L. latipes* F. (*ater* Ol., *atrovirens* Dalm.). — La forme typique paraît localisée à la province du Cap et au Natal.

La variété *dispar* Thoms. (*caffer* Fähr.), de taille généralement supérieure, vert olive avec les fémurs antérieurs et parfois aussi les médians en grande partie ou en totalité brun rouge clair, remonte jusqu'au Transvaal.

La variété *violaceus* Serv., entièrement bleue avec au plus la base des fémurs, des tarses et de quelques articles antennaires brun rouge (*ap.* Schmidt), est assez mal

définie et je crois qu'il serait préférable de réserver ce nom aux seuls exemplaires, du Cap, entièrement bleu-violacé.

La variété *suturalis* Pér. est en revanche bien caractérisée par sa bande élytrale suturale vert olive doublée d'une bande discale violet pourpre : elle est également localisée au Cap.

2. *L. geniculatus* Har. (*azurescens* Gestro, *elegans* Gestro, *janthinicornis* Kolbe) : Afrique orientale, du Nyassa à l'Ethiopie. Semble assez commune au Tanganyika. Certains exemplaires atteignent 23 mm. de long, bien que Schmidt donne comme dimensions 12 à 15 mm.

La sous-espèce *impressicollis* Lansb. qui habite le Sud-Ouest africain n'en diffère que par sa taille plus grande, sa couleur bleu sombre et sa sculpture élytrale plus fine.

3. *L. Neavei*, n. sp.

♂. Long. : 16—18 mm. — Stature allongée, cylindrique. Vert plus ou moins foncé, à reflets bleutés dans la région apicale marginale des élytres. Scape antennaire noir à reflets bleus dans la moitié distale, les articles III à XI bruns à reflets violacés. Pattes brun rouge clair, les deux tiers distaux des fémurs postérieurs bleu foncé, les tibias postérieurs et l'apex des trois premiers articles tarsaux correspondants bruns à reflets bleu-violacé. Dessous vert plus clair à fine et peu épaisse pubescence soyeuse blanche.

Front court, éparsément ponctué au milieu. Vertex à forte ponctuation, épars ou même absente au centre. Antennes une fois et demie aussi longues que le corps, le scape fortement élargi dans sa moitié distale, fortement épineux à l'apex, très grossièrement et densément ponctué. Pronotum à peine transverse, les côtés assez fortement et régulièrement courbés, avec un bourrelet peu accusé en avant; bourrelets épisterniques remontant sur le pronotum, mais demeurant très distants l'un de l'autre; le disque égal, à peine déprimé de chaque côté dans la moitié basale, à ponctuation moyenne, peu dense, surtout au milieu; l'échancrure apicale peu marquée dorsalement, assez grossièrement ridée, l'échancrure basale mieux marquée, mais courte. Écusson triangulaire, déprimé médianement. Élytres parallèles assez grossièrement granulés-ponctués, plus finement granulés-chagrinés ensuite, chaque élytre avec deux côtes discales mal indiquées. Fémurs comprimés latéralement, à massue médiocre, finement et densément ponctués, les postérieurs dépassant de très peu l'apex des élytres; tibias postérieurs étroits à la base, s'élargissant progressivement, leur marge externe très faiblement convexe.

♀. Inconnue.

Type et cotype au British Museum : Nyassaland, Sud-Ouest du Lac Chilwa (S. A. Neave, 9-I-14); un cotype de même provenance dans ma collection.

4. *L. reticulatus*, n. sp. (Boppe, in litt.).

♂. Long. : 11—17 mm. — Stature courte assez large. Vert ou bleu métallique, les articles antennaires III à XI bruns à reflets verts ou violacés. Pattes brun rouge clair, les deux tiers distaux des fémurs postérieurs, les tibias postérieurs et, en grande partie, les tarses postérieurs vert sombre ou bleu sombre, les articles tarsaux antérieurs et médians également marqués de vert ou de bleu à l'apex.

Antennes plus de deux fois aussi longues que le corps, le scape moyennement et éparsément ponctué, les articles III à XI sillonnés dorsalement sur presque toute leur longueur. Front, vertex et pronotum densément ridés-vermiculés, les rides formant une

reticulation très nette sur le disque, devenant au contraire assez régulièrement transverses sur les côtés devant et en arrière du tubercule latéral, ce dernier assez saillant, prolongé vers l'avant par un fort bourrelet; échancrure apicale bien marquée latéralement, indistincte dorsalement; échancrure basale assez forte, même dorsalement, couverte de denses rides transverses régulières. Écusson triangulaire, assez grand. Élytres courts, deux fois et demie aussi longs que leur largeur commune à la base, régulièrement et notablement rétrécis de la base à l'apex, très densément et uniformément ponctués-réticulés, la région humérale seulement finement et plutôt éparsement ponctuée. Fémurs faiblement comprimés latéralement, la massue des antérieurs et médians forte, éparsement et finement ponctuée, celle des postérieurs également forte, mais très progressive, plus densément ponctuée dans la moitié apicale; fémurs postérieurs dépassant largement l'apex des élytres; tibias postérieurs faiblement courbés, assez larges dès la base.

♀. Inconnue.

Type au Museum de Paris: Afr. orient. angl., Bura (Alluaud et Jeannel, 1950 m., Station 61, III — 1912); cotypes au British Museum et dans ma collection: Kenya, Voi (C. D. Knight, 1-V-41, n° 1243).

5. *L. subopacus* Frm. — L'examen du type ( ) de Kibanga, au Museum de Paris, permet d'affirmer qu'il s'agit bien d'un *Litopus* et non d'un *Hospes* comme le pensait Schmidt. Je n'en connais pas d'autre exemplaire. La forme des bourrelets latéraux du pronotum donne à ce dernier un aspect tout-à-fait caractéristique.

6. *L. aequabilis* Kolbe. — Espèce également bien caractérisée par son pronotum à côtés régulièrement courbés et disque égal, lisse et très luisant, orné seulement de très fins points épars, et par ses élytres luisants, éparsement et assez grossièrement ponctués à la base, puis fortement ponctués-réticulés et finalement finement et très densément ponctués-réticulés et peu brillants dans la moitié apicale. Se rencontre dans toute l'Afrique orientale.

7. *L. argentatus* Schmidt. — Je ne connais pas cette espèce, décrite de Delagoa Bay et dont Schmidt ne précise pas la punctuation pronotale.

8. *L. helymaeoides* Auriv. — Cette espèce, dont Schmidt voulait faire le type d'un genre nouveau voisin d'*Helymaeus*, est bien un *Litopus* si j'en juge par un cotype de ma collection et par de nombreux exemplaires du British Museum provenant de la même localité et des mêmes récoltes: Nyassaland, Mlanje (S. A. Neave, 4-XI-1912). Un couple de N.W. Rhodesia, Solwezi Dist. (H. C. Dollman, XI-1916), également au British Museum, n'en diffère que par le dernier article antennaire de la ♀ non plus long que l'avant-dernier et la massue des fémurs du ♂, spécialement des postérieurs, beaucoup moins forte.

9. *L. Halli*, n. sp.

♂. Long.: 13—16 mm. — Stature allongée, cylindrique. Vert olive foncé, les articles antennaires III à XI et les tibias postérieurs brun noir à reflets un peu violacés par places, les pattes brun rouge clair à l'exception de la massue des fémurs postérieurs verte, les tarses également marqués de brun violacé.

Front densément et assez grossièrement ponctué. Antennes une fois et demie aussi longues que le corps, le scape rugueusement ponctué, brièvement, mais aiguement épineux à l'apex. Pronotum sans "cou" marqué, même latéralement, avec un tubercule latéral peu élevé, non prolongé par un bourrelet, le pronotum en résumé progressivement

rétréci du tubercule latéral à l'apex et, un peu plus rapidement et encore plus régulièrement de ce tubercule à échancrure basale, celle-ci peu accusée; toute la surface couverte de très gros points arrondis contigus et peu profonds, comme chez *helymaeoides*, mais sans bande latérale de dense pubescence argentée. Écusson triangulaire, déprimé médialement. Élytres allongés, parallèles, uniformément ponctués-réticulés de la base à l'apex, à peine plus rugueux à la base que sur le reste. Fémurs postérieurs dépassant de peu l'apex des élytres, à massue moyennement forte, moins forte que chez *helymaeoides*, densément et rugueusement ponctuée; tibias postérieurs assez fortement courbés dans leur moitié distale, leur bord externe nettement convexe.

♀. Long. : 19 mm. — Différé du ♂ par les côtés du pronotum à fort bourrelet devant le tubercule latéral et par les antennes courtes et fortes, n'atteignant pas l'apex des élytres; le dernier article n'est pas plus long que l'avant dernier, à l'encontre de ce qu'on observe chez *helymaeoides*.

Types et cotypes au British Museum : N. Rhodesia, N'Changa (C. T. M a c h a m o r a, B. M. 1931—179); cotypes, de même provenance, dans ma collection.

10. *L. auricolis* Schmidt. — Décrit comme sous-espèce de *L. superbus* Lmr., mais doit être considéré comme une bonne espèce. L'exemplaire de ma collection provient, comme le type, de la région de Benito, Guinée espagnole.

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## METHODS IN SYSTEMATIC ENTOMOLOGY

By Z. P. Metcalf

The following methods in Systematic Entomology are offered out of my own experience, not in the belief that my methods are necessarily better than yours or even that any of them are as good as the methods you are now using. They are offered primarily for the benefit of the beginner and also perhaps from the selfish point of view that in the discussion you may offer methods that are better than mine which I could adopt with profit.

Systematic Entomology as I conceive it may be divided into two main fields. One of these is bibliographic research and the other is taxonomic research. In recent years the field of bibliography has been somewhat neglected and taxonomy has far outstripped it, especially in the description of new genera and species. Without further work in bibliography, however, it is not possible for taxonomic work to develop properly. Beyond stating, therefore, that there is very little possibility of over-emphasizing the importance of bibliographic work, I think we could more profitably spend our time discussing bibliographic procedures. Perhaps the importance of bibliographic procedures may seem more important to me than to some of you, because I have been, for all my productive lifetime, rather remote from great library centers. I have had to develop my own methods and accumulate my own library the hard way.

The early entomological literature is very thoroughly covered by Hagen's *Bibliotheca Entomologica*. More recently the same material has been covered by Horn and Schenckling in their *Index Litteraturae Entomologicae Serie I*. The latter literature, of course, is very thoroughly covered by the Zoological Record and by Biological Abstracts. Nevertheless, each beginning student must waste a considerable amount of time in accumulating a bibliography of the group in which he is interested. It seems, therefore, not too much to hope that soon we may have a complete bibliography covering each of the major groups of insects.

Our bibliography is typed on 3×5 cards with the author's name or authors' names and date of publication on the top line. The date is followed by a key letter which refers to a single paper. Thus the author's name, date of publication, plus the key letter is all that is necessary to refer to any item in our bibliography. By way of illustration Stal 1866 a refers to the Hemiptera-Homoptera in *Hemiptera Africana* Vol. 4. If this method were followed in catalogues and in literature cited in the various systematic publications, it would save a tremendous amount of time and energy, not to mention publication costs in these days of high printing. The name of the author and date of publication is followed on the second line by the complete title. A descriptive note is added where the title is not fully explanatory. On the bottom line is the abbreviation of the name of the journal or the full title of the book with the volume number indicated by black-face type, a colon for the page, followed by the page numbers and plates or other illustrations if any. These authors' cards are filed in 3×5 drawers alphabetically and then chronologically. There are more than 10,000 titles in our bibliography and of these I have personally verified all but about 120. Since the titles of papers do not always make it clear whether the author is referring to Hemiptera-Homoptera or Hemiptera-Heteroptera, more than twice as many titles have been investigated as are at present included in our bibliography.



The next step in any sizable bibliography is some method of indexing. In our work we have found both a journal index and a subject index very important. Our journal index consists of two sets of cards filed alphabetically. One set gives the abbreviations used for the journal together with the full title. Behind this card are filed cards which list the volume of the journal chronologically and under each volume are listed the authors who have contributed to that volume together with the date of publication and a key letter. On the other set of alphabetical cards we list stations and societies with a complete list of the journals which have been issued by them. I am repeatedly surprised at the amount of use that one makes of an index such as this—frequently to correct typographical errors in citations and also frequently in tracing the different publications by the same society or station.

The subject index is divided into three main parts: A General Part which is devoted to morphology, physiology, economics and similar subjects; a Taxonomic Part indexes the titles that refer to the super-families, families, subfamilies, and genera; and a Geographic Part, which lists the papers which have been written about Homoptera from various parts of the world. It is our belief that the arrangement of primary, secondary and tertiary headings are so clear that any worker will be able to locate any topic in which he is interested. Then he can determine easily what work has been done on this subject. Thus, if we wish to carry on further research on the morphology of the wings, we can readily turn to morphology, primary index; thorax, secondary index; wings, tertiary index and in a few moments assemble all previous work on this subject. Or, if we are interested in the taxonomy of a particular family or subfamily, we can in a few moments time find and assemble all the work that has been done on this subject. In a similar manner, if we wish to make a review of the genera and species found in any particular region of the world, we can very easily assemble what has been done on this subject by referring to the appropriate section in the geographic index.

Having assembled a bibliography with an appropriate index, the next problem is to assemble the literature. This is especially important for systematists who are isolated from the great library centers, but even if the systematic worker is adjacent to a good library he will need to have ready at hand as one of his most important tools the literature of the group on which he is working. This literature will consist of books, reprints or individual numbers of magazines, and film strips or photostats of rare or locally unobtainable items. The problem of storing this material so that it will be readily available is by no manner of means a simple one. Many different methods have been devised for storing scientific literature. One of the principle methods used in many specialized libraries is to store books, reprints and magazines on shelves with the reprints and magazines stored in special boxes and the whole arranged usually under some scheme of subject index. There are a number of defects in this system in my opinion. In the first place, most publications cannot be classified readily under a simple subject index. In the second place, this system does not allow for growth of a library without a good deal of shifting and typically a tremendous waste of space. It seems to me that the standard vertical letter files used so successfully in business everywhere in the States offers a happy solution of this problem when used in connection with our system of referring to the separate books and papers by author's name, date of publication and key letter. This system is capable of unlimited expansion and by a simple system of guide cards, books which are most appropriately stored on shelves may be referred to directly by shelf number. By another system of guides

two or more papers in the same magazine may be readily crossreferred. Film strips or photostats may be filed in appropriate folders and referred to easily. This system is, I believe, as economical on the whole as any system devised for it is not necessary to have a lot of dead space in order to allow for future expansion. This system permits complete indexing, for index cards may be made to cover every subject treated in each paper. If these index cards are then filed under carefully arranged guide cards as indicated above, any subject of interest may be fully examined.

The importance of complete and accurate species catalogues is very great. The size of the task of making a catalogue of this kind is usually not appreciated. The species catalogue of the Homoptera in my laboratory now occupies 480 drawers and certainly contains more than half a million references. Its publication will require more than 12,000 pages. Perhaps I should not but I am nevertheless compelled to say that as near as I can figure at the present time, the Homoptera are about  $1/150$  of the animal kingdom. To catalogue the animal kingdom fairly completely, therefore, would require 3,600 volumes of 500 pages each. All of our cataloguing is done on  $3 \times 5$  cards directly from the original publication and filed in  $3 \times 5$  drawers. Super-families, families, subfamilies, tribes, subtribes, genera and subgenera are indicated by appropriate guide cards. Species are filed behind cards bearing metal tabs indicating the zoogeographic region from which the species has been reported. Since so many species were originally included in genera other than the ones to which they are now referred, and since so many genera have been shifted from one family to another, a very elaborate system of cross references is necessary. After the references have been typed and filed in the appropriate category they are carefully rechecked against the original. They are then typed in manuscript form which is rechecked against the original in order to eliminate minor errors and then printed. Since we make an effort to keep our master card file up to date an elaborate system of colored cards has been developed to indicate these new references.

If our system of cataloguing seems unnecessarily elaborate we believe that a careful inspection of our system will show that the finished product is well worth the time and effort expended, and perhaps the best thing that could happen to Systematic Entomology would be the development of similar complete bibliographic catalogues of all of the orders of insects.

There are, it seems to me, three types of taxonomic work that need to be emphasized. The first is the description of the prime groups; the second is the making of keys; and the third is the making of illustrations. In our own taxonomic work which is done at irregular intervals we have found it quite profitable to take advantage of the vertical card files so largely used by American business. We have adopted the  $5 \times 8$  cards as standard. All of our descriptions, keys and illustrations are now made to fit this size drawer and all descriptive notes and illustrations are filed behind appropriate guide cards which indicate the families or other major groups, the genera with the region of the world indicated by appropriately colored guide cards, and the species whether new or old. If such notes, keys and illustrations are properly filed it is a fairly easy task to assemble a taxonomic paper.

This method of filing is especially applicable to the making of keys which formerly engaged the attention of systematists more than it does at the present time. There is no better way to delimit new genera and species than by means of a carefully prepared key. Our present system of making keys is based on a decimal system for numbering the couplets in a key. Thus 1 is the first member and 2 the second member

of the primary couplet. 1.1 and 1.2 and 2.1 and 2.2 are the first and second members of the secondary couplets. This system has the advantage in that any pair of couplets may be elevated or depressed simply by changing the numbers. Whether a member of a couplet belongs to a primary, secondary or other series is indicated further by means of small contrastingly colored metal tabs. A key set up in this manner and used repeatedly in the laboratory will very quickly show the defects, errors and other mistakes. Any member of any couplet may be corrected or removed entirely without disturbing the key as a whole.

The importance of accurate illustrations in taxonomic work cannot be over-emphasized. As the ancient Chinese proverb says: "One picture is worth 10,000 words." There are three general types of illustrations—colored drawings which may be reproduced as four-color half tones or lithographs; wash, pencil or crayon drawings which may be reproduced as half tones; and pen-and-ink outlines or shaded drawings may be readily assembled as whole-page plates or as text figures.

I believe that a short time spent in the study of the demonstration will make the whole matter much clearer than any additional remarks that I could make at this time.

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## ZUR SYSTEMATIK DER NORDEUROPAISCHEN DONACIEN

Von Tord Nyholm

Über die europäischen, besonders die mittel- und nordeuropäischen Donacien ist viel geschrieben worden. Man könnte meinen, es sei darüber das letzte Wort schon längst gesagt. Wer sich mit diesen Tieren beschäftigt, wird jedoch finden, dass hier viele, auch rein systematische Fragen noch zu lösen sind. Überhaupt ist die Systematik dieser schönen und eigenartigen Käfer trotz ihrer bedeutenden Körpergrösse und ihres zumeist sehr charakteristischen Aussehens eine recht schwierige. Nicht nur, dass die natürliche Gruppierung der Arten ein schweres Problem darstellt, ihre Einordnung in eine wirklich verwendbare Bestimmungstabelle stösst auch auf grosse Schwierigkeiten. Das hat vor allem seinen Grund darin, dass die meist in der Käfersystematik verwendeten Merkmale bei den Donacien innerhalb ein und derselben Art oft sehr variabel sind. Sehr treffend sagt der dänische Koleopterologe Victor Hansen in seiner Behandlung dieser Gattung in „Danmarks Fauna“ (ich übersetze hier aus dem dänischen): „Die meisten Schilfkäferarten sind dem Geübten auf den ersten Blick leicht kenntlich. Dagegen ist die Ausarbeitung einer Bestimmungstabelle der Arten mit grossen Schwierigkeiten verbunden, weil fast alle gebräuchlichen Kennzeichen bei den einzelnen Arten variieren. Man findet dann auch in den Tabellen der meisten Handbücher zahlreiche Fehler, oder es werden dort Kennzeichen gebraucht, die oft ganz versagen; je kürzer und scheinbar klarer die Tabellen sind, desto weniger befriedigend sind sie in der Regel.“

Die äusseren Merkmale, deren man sich in der Donaciensystematik bediente, sind vor allem die Form und Behaarung des Körpers, der Bau und die Färbung der Fühler und Beine, besonders die Länge und Bezahnung der Hinterschenkel, ferner die Form und Skulptur des Halsschildes sowie die Makro- und Mikroskulptur der Flügeldecken, einschliesslich ihrer Punktur. Wichtige Unterschiede bestehen ferner in der Form der Oberlippe und des Kopfschildes. Die Abdominalsegmente, vor allem das Tergit und Sternit des siebenten (d. h. des letzten sichtbaren) Segmentes, weisen sekundäre Geschlechtsmerkmale auf, die in gewissen Fällen auch zur Unterscheidung der Arten gebraucht werden können. Doch ist die Form des genannten Tergits nicht selten etwas variabel.

Was schliesslich die männlichen Genitalien anbetrifft, hat schon Weise (1889) auf die Verschiedenheiten in der Ausbildung des Penis und des sogenannten Fulcrum (d. h. der unpaaren, über dem Penis gelegenen Paramerenplatte) bei den einzelnen Arten hingewiesen. Der Penis ist bei den Donacien ziemlich mannigfaltig gestaltet. Die Extreme sind unter den in Nordeuropa vorkommenden Arten etwa durch *D. clavipes* F. und *D. Springeri* J. Müller vertreten. Bei der erstgenannten Art ist der Penis breiter, mit einer durch eine laterale Einengung abgesetzten, breiten Spitze, die in einen kleinen Zipfel endet. Bei *Springeri* dagegen ist er viel schlanker gebaut, gegen die Spitze stark und fast gleichmässig verschmälert. Zwischen diesen Extremen kommen allerlei Zwischenformen vor. Tatsächlich gibt es in gewissen Fällen systematisch verwertbare Unterschiede in der Penisform, z. B. in der *impressa*-Gruppe. In anderen Fällen ist dieser Unterschied bei einander nahestehenden Arten sehr gering. Schliesslich kann der Penis bei zwei oder mehreren nicht näher verwandten Arten sehr ähnlich geformt sein. Ganz allgemein kann also gesagt werden, dass die äussere Penisform in der Donaciensystematik eine ziemlich beschränkte Bedeutung hat.

In noch höherem Grade gilt dies von der Paramerenplatte. Ihre Form hängt mit der des Penis zusammen: bei einem langen und schlanken Penis ist sie lang und schmal, bei einem kurzen Penis auch kurz und mehr oder weniger verbreitert. Im übrigen ist aber diese Platte ziemlich einförmig gestaltet.

Viel wichtiger als die äussere Form ist indessen die innere Struktur des männlichen Kopulationsorganes, die, wie es scheint, bisher sehr wenig Beachtung gefunden hat. Die beschränkte Zeit gestattet mir nicht, auf die Einzelheiten des inneren Penisbaues näher einzugehen. Die auf Grund von Nelkenölpräparaten angefertigten Bilder (vgl. Fig. 2) mögen eine Vorstellung davon geben.

Unter den nordeuropäischen Donacien sind es hauptsächlich diejenigen Arten, die sich um *impressa* Payk., *obscura* Gyll. und *antiqua* Kunze gruppieren, welche bei der Determination Schwierigkeiten bereiten können. Nur diese Arten sollen daher im folgenden etwas näher erörtert werden. Der von ihnen gebildete Artenkomplex hat für die nordischen Koleopterologen ein besonderes Interesse, weil zwei zu diesem Komplex gehörende Arten, nämlich *brevitarsis* Thoms. und *aureocincta* J. Sahlb., aus Fennoskandien beschrieben sind, und zwar die erste aus Schweden, die zweite aus Finnland. Über diese beiden Arten geben die Bestimmungsbücher im allgemeinen sehr wenig Auskunft, und sie sind auch den nordischen Entomologen ziemlich unbekannt und rätselhaft geblieben. *D. aureocincta*, von J. Sahlberg 1921 beschrieben, wurde später nur als eine Aberration von *obscura* Gyll. betrachtet. Als solche ist sie auch im nordischen Käferkataloge, *Catalogus coleopterorum Daniae et Fennoscandiae* (1939), im folgenden kurz *Catalogus* 39 genannt, aufgenommen. Der Thomson'schen Art *brevitarsis* ist es noch schlechter ergangen. Sie wurde 1884 ganz kurz ohne Fundortsangabe beschrieben. In dem von Grill ausgearbeiteten Verzeichnis der nordischen Kolepteren (1896) wurde die Art als in Schonen und Russisch-Karelien angetroffen angegeben. Der *Catalogus* 39 nimmt sie nur für Schonen auf (übrigens ist die Art hier durch ein Fragezeichen als unklar bezeichnet), und in dem zuletzt erschienenen Verzeichnis unserer Käfer, *Enumeratio insectorum Fenniae et Sueciae*, II. Coleoptera (1947), findet sie überhaupt keine Erwähnung. Wir finden also, dass diese Art aus ihrer *patria* schlechthin verschwunden ist, ohne auch nur in den Synonymenlisten irgendwelche Spuren zu hinterlassen, ein recht seltsames Verhältnis, um so bemerkenswerter, als sich der Typus im Entomologischen Museum zu Lund in dem dort aufbewahrten Teil der Thomson'schen Sammlung befindet.

Ehe ich dazu übergehe, einige der Ergebnisse meiner Untersuchung über die hier zu behandelnden Arten kurz zu besprechen, will ich die wichtigsten Resultate dieser Untersuchung vorausschicken. *D. aureocincta* ist als gute Art wieder aufgestellt worden, *brevitarsis* hat sich als ein wenigstens in Schweden weit verbreiteter, wenn auch seltener Schilfkäfer erwiesen, wogegen *antiqua* Kunze wenigstens vorläufig aus der schwedischen Fauna gestrichen werden muss. Schliesslich wurde höchst überraschend das Vorkommen einer für das Faunengebiet neuen Donacia, *D. Springeri* J. Müller, in Südschweden festgestellt.

Der betreffende Artenkomplex umfasst folgende nordeuropäische Arten: *impressa* Payk., *thalassina* Germ., *brevicornis* Ahr., *obscura* Gyll., *aureocincta* J. Sahlb., *antiqua* Kunze, *brevitarsis* Thoms. und *Springeri* J. Müller, also acht von den zweiundzwanzig bisher innerhalb des Gebietes aufgefundenen Arten.

All diesen Arten sind folgende Kennzeichen gemeinsam: die Fühler und Beine sind ganz dunkel gefärbt; die Hinterschenkel sind verhältnismässig kurz, erreichen lange nicht die Spitze der Flügeldecken und sind mit einem mehr oder weniger starken

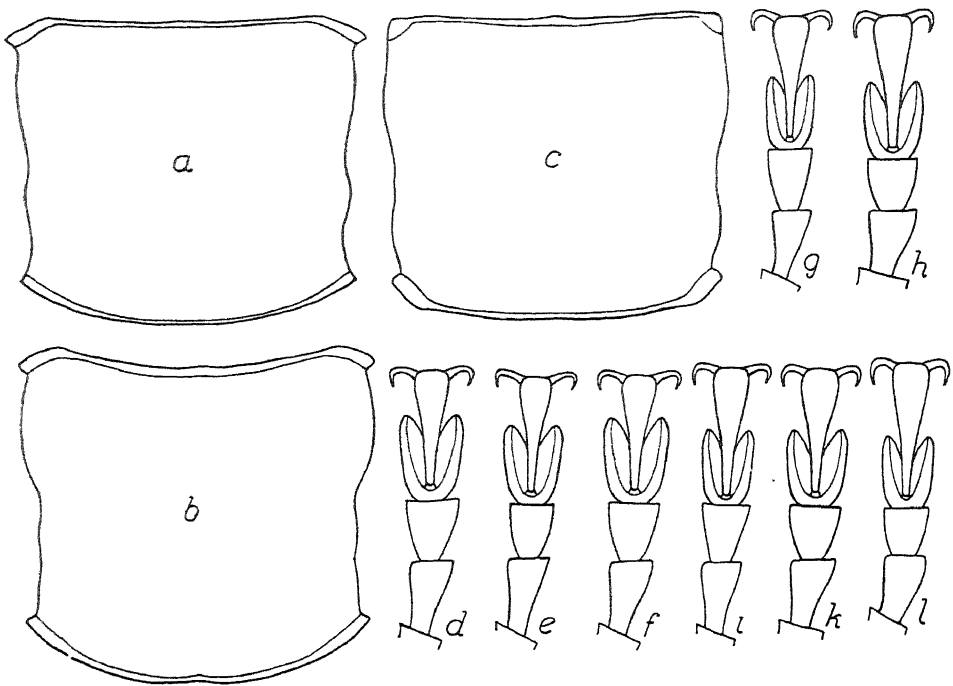


Fig. 1. Halsschild von a. *Donacia aureocincta*, b. *D. brevitarsis*, c. *D. Springeri*.  
Rechte Hintertarse von d. *D. impressa*, e. *D. thalassina*, f. *D. brevicornis*, g. *D. obscura*, h. *D. aureocincta*, i. *D. antiqua*, k. *D. brevitarsis*, l. *D. Springeri*.

Zahn versehen, der jedoch bei einigen Arten, besonders bei kleinen Stücken, fast oder ganz verschwunden sein kann. Die Flügeldecken zeigen mehr oder weniger deutliche Eindrücke.

Wie sich die Arten des Komplexes von einander unterscheiden, brauche ich hier nicht näher auseinanderzusetzen. Das geht aus der am Schluss mitgeteilten Bestimmungstabelle hervor. Es seien nur einige Worte über diese Tabelle gesagt. Bei der Ausarbeitung einer Bestimmungstabelle muss man selbstverständlich in erster Hand praktische Gesichtspunkte vor Augen haben. Doch ist es ganz natürlich wünschenswert, dass in einer solchen Tabelle auch die vermutlichen Verwandtschaftsbeziehungen der Arten soweit wie möglich zum Ausdruck gelangen. Ich habe also versucht, solche Merkmale herauszufinden, die eine Einteilung des grösseren Artenkomplexes in kleinere, natürliche Gruppen ermöglichen. Eines der in den Tabellen zur Einteilung der hier in Frage stehenden Arten am häufigsten verwendeten Kennzeichen, die Stärke des Hinterschenkelzahnes, finde ich nicht brauchbar. Denn bei Anwendung dieses Kennzeichens werden in der Tat einander nahestehende Arten, wie *thalassina* und *brevicornis*, auseinandergerissen und zu verschiedenen Gruppen gezählt, ganz abgesehen davon, dass die Stärke dieses Zahnes oft bei ein und derselben Art je nach Geschlecht und Grösse des Individuums sehr beträchtlich variieren kann, so dass dieses Kennzeichen stets ein solches zweiten Ranges bleibt.

Die untersuchten Arten lassen sich ziemlich zwanglos in zwei Gruppen teilen. Der wichtigste Unterschied zwischen diesen beiden Gruppen liegt im Bau der Füsse. Schon Thomson hat auf dieses von späteren Autoren kaum berücksichtigte Merkmal aufmerksam gemacht. Vergleichen wir z. B. eine Hintertarse von *D. impressa* mit einer von *antiqua* (Fig. 1 d und i), so finden wir, dass das vierte Glied bei *impressa* verhältnismässig viel kürzer ist, so dass sich das dritte Glied weit über die Mitte des vierten erstreckt. Bei *antiqua* dagegen ist das vierte Glied viel länger, das dritte erreicht nur die Mitte des vierten. Zwischen *impressa* und *Springeri* (Fig. 1 l) ist der Unterschied noch beträchtlicher. Mit *impressa* stimmen in dieser Beziehung *brevicornis* und *thalassina* überein, mit *antiqua* dagegen die Arten *obscura*, *aureocincta*, *brevitarsis* und *Springeri*. Die drei erstgenannten, unzweifelhaft sehr nahe verwandten Arten werden somit in der ersten Gruppe vereinigt, die zweite, mehr heterogene Gruppe setzt sich aus den fünf letztgenannten Arten zusammen. Innerhalb dieser zweiten Gruppe gehört, nach äusseren Merkmalen zu urteilen, *obscura* mit *aureocincta* näher zusammen, wie auch *antiqua* mit *brevitarsis*, während *Springeri* eine mehr isolierte Stellung einnimmt.

Wie verhalten sich nun die hier behandelten Arten in Bezug auf den inneren Bau des Penis zu einander? Wird die hier gegebene Einteilung auch durch Übereinstimmungen in der inneren Penisstruktur gestützt? Und falls nicht, soll den äusseren Merkmalen in systematischer Hinsicht grösserer Wert beigemessen werden als dem Bau der männlichen Genitalien? Auf diese für die Systematik sehr wichtige Frage kann ich leider heute nicht näher eingehen. Ich glaube, es gibt darauf keine allgemein gültige Antwort.

Bei einer Untersuchung der inneren Penisstruktur der betreffenden Arten findet man, dass die meisten derselben weitgehende Übereinstimmung zeigen. Besonders gut stimmen die Arten der zweiten Gruppe, *impressa*, *thalassina* und *brevicornis*, mit einander überein (Fig. 2 m, n, o). Nur *brevitarsis* (Fig. 2 s) weicht in dieser Beziehung erheblich von den übrigen ab, wie diese Art auch hinsichtlich der äusseren Form des Penis eine Sonderstellung innerhalb des Komplexes einnimmt. *D. Springeri* (Fig. 2 t) weist eigentümlicherweise in Bezug auf das innere Chitingerüst des Penis eine gewisse Ähnlichkeit mit *D. bicolor* Zschach auf.

Zum Schluss möchte ich noch einige Worte über die drei interessantesten Arten des Komplexes, *aureocincta*, *brevitarsis* und *Springeri*, sagen. J. Sahlbergs Beschreibung von *aureocincta* ist sehr ausführlich und für eine Identifizierung der Art vollständig ausreichend. Ausserdem habe ich auch Gelegenheit gehabt, den im Zoologischen Museum zu Helsingfors aufbewahrten Typus (ein ♀) zu untersuchen. Die Art ist in Südfinnland und in Mittel- und Nordschweden gefunden worden, scheint aber sehr selten zu sein.

Die verkannte *D. brevitarsis* ist in Wirklichkeit eine sehr leicht kenntliche Art. Durch ihren plumpen Bau und starken Glanz erinnert sie an die *Plateumaris*-Arten der *discolor*-Gruppe. Das Typenexemplar (ein ♀) trägt die Fundortsetikette Norl. (= Norrland). Woher die Angabe für Schonen herrührt, die in der einschlägigen Literatur wiederholt vorkommt, weiss ich nicht. Beim Durchgehen der Sammlungen schwedischer Museen und Privatsammler habe ich mehrere Stücke dieser Art entdeckt, die unter *impressa* oder *antiqua* steckten. Die Art ist jetzt aus fünf Provinzen Schwedens sicher bekannt. Besonders scheint sie im östlichen Mittelschweden vorzukommen. An einem Fundort in der Nähe von Stockholm wurde sie mit *impressa* zusammen auf Carices in mehreren Exemplaren gefangen. Die Art kommt auch in Finnland vor und im Naturhistorischen Reichsmuseum finden sich Stücke dieser Art auch aus Deutschland. Sie dürfte demnach in Europa weiter verbreitet sein.

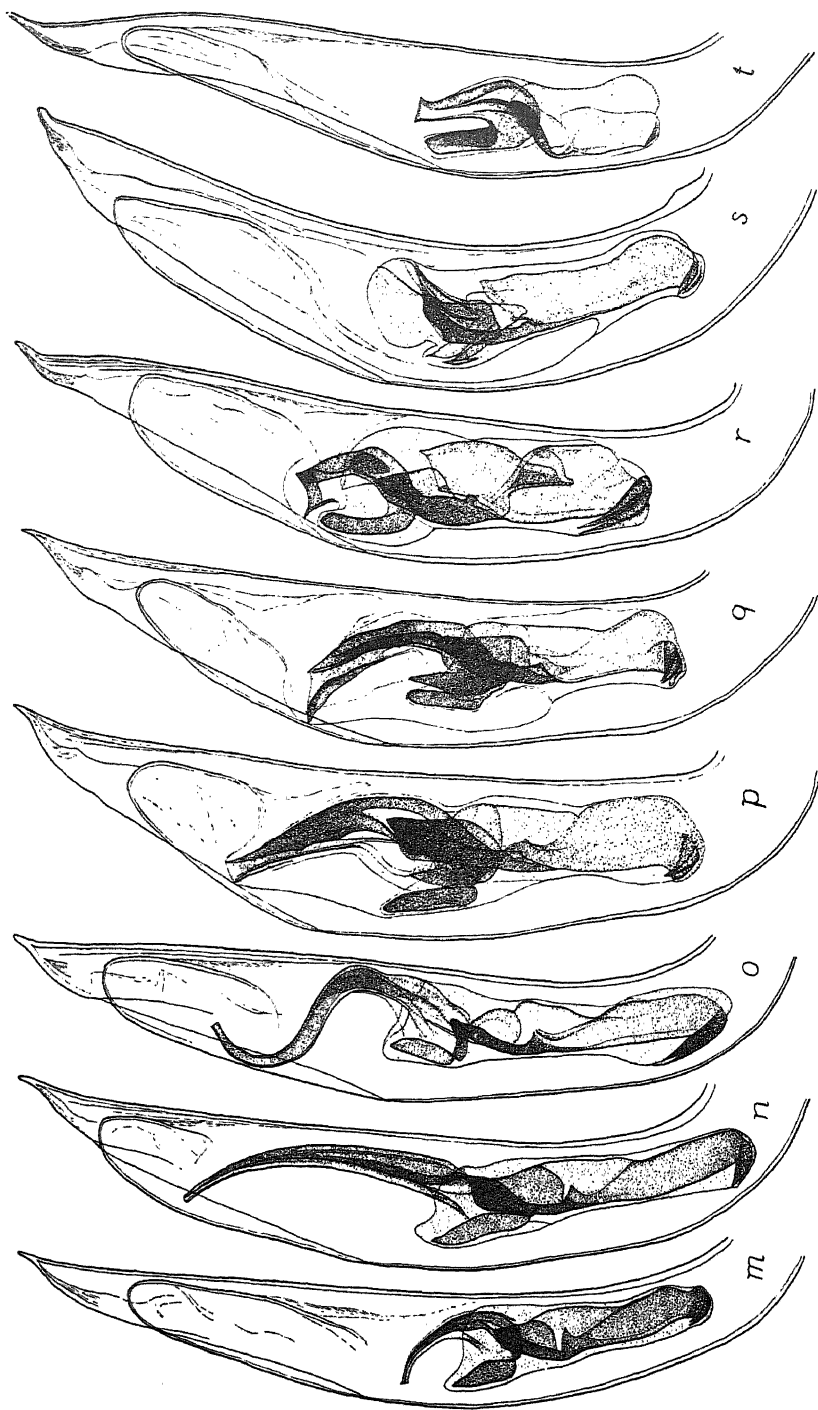


Fig. 2. Penis (von der Seite gesehen) von m. *Donacia impressa*, n. *D. thalassina* o. *D. brevicornis*; p. *D. obscura*, q. *D. aureocincta*, r. *D. antiqua*, s. *D. brevitarsis*, t. *D. Springeri*.



In den alten Sammlungen des Lunder Entomologischen Museums bin ich auf mehrere Stücke einer *Donacia* gestossen, die unter dem Namen *brevicornis* Gyll. steckten und aus Mittelschonen stammten. In der Literatur wird *brevicornis* Gyll. nec Ahr. als Synonym von *antiqua* angesehen. Die betreffenden Stücke konnten aber unmöglich zu dieser Art gehören. Dagegen stimmten sie mit der Beschreibung von *D. Springeri* J. Müller im wesentlichen gut überein. Dass diese aus Norditalien (Monfalcone) beschriebene, nur noch an einer Stelle in Süddeutschland aufgefundene Art auch in Südschweden vorkommen sollte, kam mir doch etwas unwahrscheinlich vor. H. Bollow, München, der das Vorkommen der Art in Deutschland gemeldet hat, und dem ich eine Zeichnung der bei dieser *Donacia* sehr charakteristisch geformten Penis Spitze zusandte, war indessen auch der Meinung, es müsste sich um *D. Springeri* handeln. Vom Autor wird diese Art am nächsten mit *impressa* verglichen, von Bollow mit *impressa* und *brevicornis*. Wegen des Baues der Füsse und der Skulptur des Halsschildes zähle ich sie aber zu der zweiten Gruppe des hier behandelten Artenkomplexes.

Im Catalogus 39 wird *D. antiqua* für einige schwedische Provinzen angegeben. Es handelt sich aber in der Tat um *brevitarsis*. Ich habe noch kein schwedisches Stück von *antiqua* gesehen, dagegen scheint diese Art in Finnland weit verbreitet zu sein. Die Art, die in „Danmarks Fauna“ unter dem Namen *antiqua* Kunze behandelt wird, ist zweifelsohne ebenfalls *brevitarsis* Thoms.

Mit dieser etwas summarischen Darstellung habe ich zeigen wollen, dass, wie ich in der Einleitung bereits sagte, auch eine Käfergattung wie *Donacia*, deren Arten stets viel gesammelt und studiert werden, immer noch systematische Probleme bieten kann. Vor allem möchte ich die Aufmerksamkeit auf die grosse Bedeutung der inneren Penisstruktur dieser Koepteren richten. Ich hoffe, hierüber eine ausführlichere Arbeit bald veröffentlichen zu können.

### Bestimmungstabelle

- 1 (6) 4. TrGld. verhältnismässig kürzer; 3. Gld. der HTr. die Mitte des 4. mehr oder weniger überragend,  $pi:pe=1,4-1,6:1$  (Fig. 1 d—f). Punktur des Hsch. auf der Scheibe nicht oder nur schwach runzelig. Zahn der HSchl. mitunter schwach oder sogar undeutlich.
- 2 (3) 1. Zwischenraum der Fld. unregelmässig längsrunzelig, seine Spitze (von der Seite gesehen) in der Regel kammartig aufgerichtet. Punktreihen der Fld. feiner. Stirn breit, Augen stark vorgewölbt. 3. Gld. der HTr. die Mitte des 4. weit überragend,  $pi:pe=1,6:1$  (Fig. 1 d). VEcken des Hsch. deutlich zahnförmig hervorstehend, der Zahn kaum über den Seitenrand des Seitenhöckers hinausreichend. Zahn der HSchl. schwach oder undeutlich. HSchn. stark gebogen. Penis Fig. 2 m. .... *impressa* Payk.
- 3 (2) 1. Zwischenraum der Fld. unregelmässig querrunzelig, seine Spitze (von der Seite gesehen) nicht kammartig aufgerichtet. Punktreihen der Fld. gröber.
- 4 (5) 3. TrGld. etwas kürzer; 3. Gld. der HTr. die Mitte des 4. nicht so weit überragend,  $pi:pe=1,4:1$  (Fig. 1 e). Zahn der HSchl. immer deutlich, in der Regel ziemlich kräftig. HSchn. schwächer gebogen. Stirn breiter, Augen stärker vorgewölbt. VEcken des Hsch. deutlich zahnförmig hervorstehend, der Zahn über den Seitenrand des Seitenhöckers deutlich hinausreichend. Körper etwas gestreckter. Penis Fig. 2 n. .... *thalassina* Germ.

- 5 (4) 3. TrGld. länger; 3. Gld. der HTr. die Mitte des 4. weiter überragend, pi:pe = 1,6:1 (Fig. 1 f). Zahn der HSchl. sehr schwach, oft ganz undeutlich. HSchn. stärker gebogen. Stirn schmaler, Augen in der Regel weniger stark vorgewölbt. VEcken des Hsch. nur schwach oder kaum zahnförmig hervorstehend, der Zahn nicht über den Seitenrand des Seitenhöckers hinausreichend. Körper etwas breiter. Penis Fig. 2 o. .... *brevicornis* Ahr.
- 6 (1) 4. TrGld. verhältnismässig länger; 3. Gld. der HTr. höchstens die Mitte des 4. erreichend, pi:pe = 0,9—1:1 (Fig. 1 g—l). Punktur des Hsch. mehr oder weniger deutlich, meist stark runzelig. Zahn der HSchl. immer deutlich, meist kräftig.
- 7 (14) VEcken des Hsch. deutlich zahnförmig hervorstehend (Fig. 1 a und b). Punktreihen der Fld. gedrängt punktiert, im Apikalteil entweder mehr oder weniger unregelmässig oder undeutlich. Durchschnittlich grössere (7,7—10,7 mm), kräftig gebaute Arten. Zahn der dicken HSchl. stets stark. Behaarung der US. gelblich.
- 8 (11) Seitenhöcker des Hsch. schwach ausgebildet, seitlich nicht vorgebeult. Seiten des Hsch. daher vorne fast gerade oder nur schwach gebuchtet (Fig. 1 a). VEcken scharf zahnförmig hervorstehend, der Zahn weit über den Seitenrand des Hsch. hinausreichend. Punktreihen der Fld. bis zur Spitze deutlich, im Apikalteil mehr oder weniger unregelmässig.
- 9 (10) Tr. länger und schlanker (Fig. 1 g); 2. Gld. der VTr. länger als breit. Fld. sehr fein und dicht, unregelmässig gerunzelt, fast matt erscheinend, innerhalb der Schultern mit einer Anzahl sehr dicht gestellter, zum Teil verfloßener Punkte, die inneren Zwischenräume an der Basis in der Regel mit zahlreichen, unregelmässig gestellten Punkten. Durchschnittlich etwas grösser (8,5—10,7 mm), oben dunkel bronzefarbig (sehr selten dunkel blaugrün), oft mit schwachem, grünlichem Schimmer. Penis Fig. 2 p. .... *obscura* Gyll.
- 10 (9) Tr. kürzer und breiter (Fig. 1 h); 2. Gld. der VTr. breiter als lang. Fld. etwas weniger dicht gerunzelt, daher etwas glänzender, die Punktur innerhalb der Schultern weniger dicht, nicht verfloßen, die inneren Zwischenräume an der Basis (mit Ausnahme des 4.) nur mit wenigen unregelmässig gestellten Punkten. Durchschnittlich etwas kleiner (8,5—9,5 mm), oben dunkler oder heller purpurfarbig. Penis Fig. 2 q. .... *aureocincta* J. Sahlb.
- 11 (8) Seitenhöcker des Hsch. stärker entwickelt und seitlich vorgebeult. Seiten des Hsch. daher vorne stark gebuchtet (Fig. 1 b). VEcken weniger scharf zahnförmig hervorstehend, der Zahn nicht oder kaum über den Seitenrand des Hsch. hinausreichend. Punktur der Fld. im Apikalteil undeutlich.
- 12 (13) Weniger breit gebaut, weniger glänzend. Fld. hinten länger und stärker, geradlinig zugespitzt, vor der Spitze nicht auffallend stark gerunzelt, ihre Punktreihen feiner, hinten in schwach vertiefte, sehr fein, zum Teil undeutlich punktierte Furchen übergehend. 2. Gld. der F. schlanker. Färbung: oben sehr konstant dunkel bronze- oder kupferfarbig. Penis Fig. 2 r. . . *antiqua* Kunze.
- 13 (12) Kürzer und breiter gebaut, stark glänzend (an die *Plateumaris*-Arten der *discolor*-Gruppe sehr erinnernd). Fld. kürzer zugespitzt mit hinten schwach gerundeten Seiten, Punktreihen viel gröber, im Apikalteil nicht furchenartig vertieft, die unregelmässige Punktur hier wegen der auffallend starken Runzelung ziemlich undeutlich. 2. Gld. der F. sehr kurz. Typische Färbung:

- oben messingfarbig, die Seiten des Hsch. und die äusseren Zwischenräume der Fld. mit deutlichem, grünlichem Schein. Penis Fig. 2 s. *brevitarsis* Thoms.
- 14 (7) VEcken des Hsch. nicht zahnförmig hervorstehend (Fig. 1 c), Seiten des Hsch. fast gerade. Punktreihen der Fld. ziemlich fein, auffallend weitläufig punktiert, bis zur Spitze deutlich und fast regelmässig, Zwischenräume fein und dicht gerunzelt, ziemlich schwach glänzend. Durchschnittlich kleiner (7,5—8,5 mm), weniger kräftig gebaut. Zahn der schlankeren HSchl. mitunter ziemlich schwach. Oben dunkel bronzefarbig, Behaarung der US. weisslich. Penis Fig. 2 t. .... *Springeri* J. Müller.

### Erklärung der Abkürzungen

pi (pars interior) = der innerhalb der beiden Lappen des 3. Gliedes gelegene Teil des 4. Tarsengliedes.

pe (pars exterior) = der ausserhalb der Spitze des 3. Gliedes gelegene Teil des 4. Tarsengliedes.

Die übrigen Abkürzungen sind dieselben, die Reitter in „Fauna Germanica“ anwendet.

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## PARALLELE VARIATION BEI ORTHOPTEREN

Von *W. Ramme*wird in Deutschland veröffentlicht.  
  

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## DIE VARIABILITÄT DER ANDRENA-ARTEN DES KARPATENBECKENS

(Hym., Apidae)

Von Gabriel Stohl

Die auffallend grosse Zahl der bisher bekannten *Andrena*-Arten, die überaus weite Verbreitung dieser Gattung und der Umstand, dass sie in den verschiedensten Biotopen, wenn auch nur durch einige Arten, aber doch vertreten ist, weisen eindeutig darauf hin, dass die Bienengattung *Andrena* eine in Entwicklung begriffene, sich auch noch heute weiterentwickelnde Gruppe der Hymenopteren darstellt. Die Weiterentwicklung der Arten, die völlige Umprägung der alten Typen geht aber — wie im allgemeinen bekannt — bei den Insekten sehr langsam vor sich. Die Herausgestaltung neuerer Arten beschränkt sich nicht nur auf eine verhältnismässig kurze Periode der Erdgeschichte, sondern bleibt durch eine, auch im geologischen Sinne langdauernde Epoche erhalten. Die sprunghaft auftretenden Formumprägungen, die Mutationen, denen auch in der Stammesentwicklung der Insekten eine nicht abzuleugnende, wesentliche Rolle zukommt, treten nicht nur in einer kurzdauernden Periode (etwa Mutationsperiode) auf, sondern eine lange Epoche hindurch. Trotzdem die Gattung *Andrena* schon im unteren Oligocen erschien (im baltischen Bernstein *Andrena* sp.) und im Miozen auch in Nordamerika verbreitet war (*A. percontusa* Cock., *hypolitha* Cock., *sepulta* Cock., *grandipes* Cock., sämtliche von Florissant im Colorado), erfuhr der Grundbauplan der hierhergehörigen Tiere noch keine tiefgreifende Umwandlung; die *Andrena*-Arten bewahren ihre Charakterzüge vom Oligocen bis zum heutigen Tage unverändert. Die auch noch heute stattfindende Weiterentwicklung der Formen überschreitet nicht die Rahmen dieses Grundtypus und führt nicht zu entarteten, überdifferenzierten Formen. Die Gattung *Andrena* befindet sich in einem ganz besonderen Zustande der Stammesentwicklung; das Fehlen der entarteten, überdifferenzierten, degenerierenden Formen schliesst die Möglichkeit der typolytischen Phase (im Sinne Schindewolf's) von vornherein aus; ausserdem spricht auch die grosse ökologische Plastizität der Gattung gegen eine phylogenetische Überdifferenzierung. Auch die zweite Phase der stammesgeschichtlichen Entwicklung, die Typostase, kann mit vollem Recht ausseracht gelassen werden, da in dieser Phase nur eine allmähliche Weiterentwicklung der schon vorhandenen Formen, also eine allmähliche Spezialisierung stattfindet, was aber in unserem Falle keinesfalls zutrifft. Wie weiter unten noch ausführlicher dargestellt wird, gehören bei dieser Gattung die sprunghaften, also den Mutationen gleichzustellenden Umgestaltungen nicht zu den Seltenheiten. Wenn sich aber die Gattung *Andrena* in keiner der beiden genannten Phasen der Stammesentwicklung befindet, so bleibt nur als letzte Möglichkeit anzunehmen, dass bei ihr die im allgemeinen kurzdauernde Phase der Stammesentwicklung, die Typogenese, aus irgendwelchen, zur Zeit noch näher nicht bekannten Ursachen langdauernd geworden ist. Aus diesen Gründen ist die mehr phylogenetische, als rein systematische Betrachtung dieser Gattung für die Erforschung der Wege der Evolution nicht ohne Bedeutung, da hier gerade die sonst stürmisch ablaufende Phase der Entwicklung langdauernd und daher besser zu erforschen ist.

Aus diesen Erwägungen geht nun mit aller Deutlichkeit hervor, dass eine von diesem Standpunkte aus durchgeführte Bearbeitung der *Andrena*-Arten eines abgeschlossenen geographischen Gebietes sowohl für die Systematik, als auch für die Abstammungslehre nicht ohne Bedeutung ist. In diesem Aufsatz möchte ich meine während der Unter-

suchung der *Andrena*-Arten des Karpatenbeckens über die Variabilität dieser Tiere gewonnenen Eindrücke kurz mitteilen. Die monographische Bearbeitung dieser Gattung wird in den *Annales Historico-Naturales Musei Nationalis Hungarici* erscheinen. Das dieser Arbeit zugrundeliegende Material (etwa 5000 Exemplare) befindet sich im Besitz des Ungarischen Naturwissenschaftlichen Museums (Budapest); ausserdem wurden aber auch einige Privatsammlungen berücksichtigt.

Unter den 60 mit Sicherheit nachgewiesenen *Andrena*-Arten des Karpatenbeckens sind nur einige variabel, wie *Andrena minutula* K., *A. ovatula* K. (*convexiuscula* K.) und *A. varians* K. Die überwiegende Mehrzahl der Arten ist durch eine grosse Beständigkeit ihrer Merkmale ausgezeichnet. Als solche ständige, „gute“ Arten erweisen sich diejenigen, die im Karpatenbecken die Grenze ihres Hauptverbreitungsgebietes erreichen, die also im Osten oder im Süden ihr Hauptverbreitungsgebiet besitzen, oder nur in bestimmten Biotopen vorkommen, im ökologischen Sinne also als stenök eremophil oder als stenök hylophil bezeichnet werden können. Im Gegensatz dazu sind die nicht an gewisse Biotope gebundenen hypereuryök intermediären Arten meistens in hohem Grade variabel.

1. Der Zahn an der Oberkieferbasis von *Andrena rosae* Pz. Früher wurde diesem Gebilde in der Charakterisierung einiger Arten (*eximia* Sm., *rosae* Pz. und *austriaca* Schmdk.) eine grosse systematische Bedeutung zugeschrieben, da seine Anwesenheit oder sein Fehlen, sowie seine Länge bei der Trennung der einzelnen Arten eine grosse Rolle spielte. Diese Annahme erwies sich aber keinesfalls als zutreffend, da die Gestalt des männlichen Kopulationsapparates und die der beiden letzten Bauchplatten, sowie die äusseren morphologischen Merkmale bei sämtlichen dieser „Arten“ identisch sind, völlig unabhängig davon, ob der Zahn anwesend ist oder fehlt, ob er länger ist oder kürzer.

2. Gestalt der Mandibelbasis bei den Männchen von *Andrena praecox* Scop. Diese auch äusserlich der *A. varians* K. sehr nahestehende Art (allgemeine Körpergestalt, Skulptur des Mittellückens und Hinterleibes, unten eckig ausgebildete Schläfen) lässt sich von *A. varians* durch die Form ihrer Mandibeln leicht unterscheiden, da die Basis der Mandibeln mit einem breiten, am Ende abgerundeten „Zahn“ versehen ist. Doch kann diese Abweichung keine entscheidende sein, da zwischen den einfachen und den mit einem „Zahn“ ausgestatteten Mandibeln alle möglichen Übergangsformen vorkommen. Neben Tieren, die an ihrer Mandibel einen deutlichen „Zahn“ tragen, sind — an demselben Fundort — auch solche anzutreffen, deren Mandibelbasis einfach oder kaum etwas ausgebreitet ist. Noch eingeschränkter wird die systematische Bedeutung dieses Merkmals dadurch, dass die sonst bezeichnende Gestalt des männlichen Kopulationsapparates und die der beiden letzten Bauchplatten den Verhältnissen bei *variens* entspricht, unabhängig der Anwesenheit des „Zahnes“. Dass sich die Form der Mandibelbasis aber nicht rein zufällig in den Rahmen einer gegebenen und für die betreffende Art bezeichnenden Variabilität entwickelt, sondern in ihrer Form von bestimmten Allelen einer Allelreihe abhängig ist, wird durch die Tatsache bestätigt, dass an einigen Fundorten mehr *variens*-artige, an anderen mehr *praecox*-artige Exemplare gesammelt wurden. Daneben gibt es Fundorte, wo beide Formen nebeneinander vorkommen. Es soll noch erwähnt werden, dass bei der der *variens* systematisch sehr nahestehenden *ventralis* Imh., die sich von *variens* — im männlichen Geschlecht — durch den gelben Fleck des Kopfschildes, sowie die Gestalt des 3. Geisselgliedes (bei *variens* ist dieses Glied länger als breit, bei *ventralis* kürzer als breit)

unterscheidet, ein solcher „Zahn“ an der Mandibelbasis niemals festgestellt werden konnte.

3. Form des Anhanges der Oberlippe bei den Weibchen von *Andrena ovatula* K. Bei allen übrigen Arten des Karpatenbeckens erwies sich dieses Merkmal als sehr brauchbar für die Trennung der Weibchen, da in der Form dieses Gebildes nur unwesentliche Abweichungen vorkommen, die den Grundtypus stets unberührt lassen. Nicht so bei den Weibchen von *ovatula* K. Von kleinen, schmalen, zapfenartigen Anhängen kommen alle möglichen Übergangsformen bis zu grossen, lamellenartigen Anhängen vor (Abb. 1); ausserdem kann dieser Anhang ganzrandig sein oder mehr oder weniger ausgerandet. Diese in der Form des Anhanges der Oberlippe auftretende Variabilität hat mit der geographischen Variabilität nichts zu tun; zwischen der Form dieses Anhanges und der geographischen Lage des Fundortes besteht kein Zusammenhang. Die unter den einzelnen Populationen auftretenden Unterschiede sind aber nicht ganz unregelmässig. In einer bestimmten Population bleibt — trotz der Variabilität — die für die Population charakteristische Form des Anhanges unverändert. Besitzt z. B. der Anhang eine breite, lamellenartige Gestalt in der betreffenden Population, so kann er höchstens schmaler oder breiter sein; eine zapfenförmige Gestalt wird er nur bei einigen Exemplaren annehmen können (Abb. 1. 1—3, 4—6). Wenn aber die betreffende Population durch einen zapfenartigen Anhang ausgezeichnet ist, so kann nur die Breite oder Länge des Zapfens variieren; die zapfenartige Form bleibt aber immer unverändert; selbstverständlich treten ausnahmsweise auch in diesem Falle breite, lamellenartige Anhänge auf. Diese Variabilität des Oberlippen-Anhanges scheint also dem von B. Rensch eingeführten Begriff der Kolonievvariabilität zu entsprechen. Mit diesem Begriff bezeichnete B. Rensch das Vorherrschen bestimmter Merkmale, das nichts mit der geographischen Variabilität zu tun hat und doch zu einem reellen, variationsstatistisch gut erfassbaren Unterschiede führt. Dass aber auch diese Form der Variabilität genetisch bedingt ist, geht aus den Untersuchungen C. Stern's über das Gen *ci* („cubitus interruptus“) bei *Drosophila melanogaster* hervor. C. Stern gelang nämlich

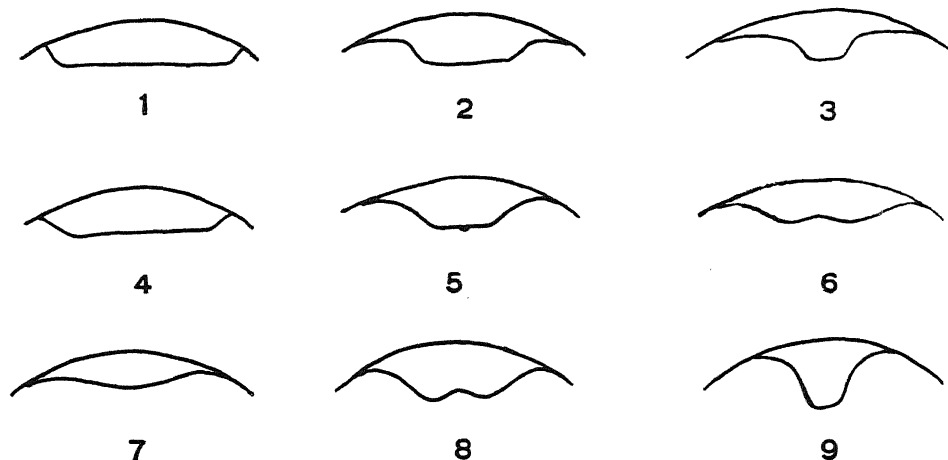


Abb. 1. Verschiedene Formen des Oberlippen-Anhanges bei den Weibchen von *Andrena ovatula* K. 1—3. Fundort Boksánbánya (15. VII. 1911), 4—6 Fundort Mehádía, 7 Debrecen, 8 Nagyenyed, 9 Szigetszentmiklós.

der Nachweis, dass jede Population durch ein bestimmtes Allel des *ci* — Genes charakterisiert ist; daneben kommen aber in allen Populationen in grösserer oder kleinerer Zahl auch andere Geäderformen, also auch andere Allele der *ci* — Allelreihe vor (p. 444). Aus diesen analogen, auch experimentell gesicherten Versuchsergebnissen kann man also den Rückschluss ziehen, dass bei *Andrena ovatula* im weiblichen Geschlecht die Form des Anhangs der Oberlippe von einem solchen Gen geregelt wird, welches sämtliche seiner Allele besitzt.

4. Die Gestalt der ersten Geisselglieder. Dieses Merkmal ist ausserordentlich charakteristisch für die einzelnen Arten, da es sich bei den meisten *Andrena*-Arten des Karpatenbeckens als nahezu konstant erwies; nur bei *Andrena minutula* K. und *varians* K. kommt auch hinsichtlich dieses Merkmals eine Variabilität zum Vorschein. Bei *minutula* besitzt das Verhältnis zwischen Länge und Breite des 3. und 4. Geisselgliedes im allgemeinen den Wert 0,66: 1,00, bzw. 1,00: 1,00; es kommen aber auch Exemplare vor, bei welchen diese Werte 1,00: 1,00, bzw. 1,30: 1,00 sind. Dies bedeutet, dass bei der überwiegenden Mehrzahl der Exemplare das 3. Geisselglied bedeutend kürzer als breit ist, während das 4. ungefähr so lang ist wie breit; bei einigen Exemplaren besitzt aber schon das 3. Geisselglied eine kubische Gestalt, während das 4. merklich länger ist als breit. Es ist wohl möglich, dass diese Variabilität event. eine Kolonievariabilität ist, doch spricht der Umstand, dass auch solche Tiere sich hinsichtlich der ersten Geisselglieder voneinander unterscheiden, die an demselben Fundort zu derselben Zeit gesammelt wurden, dafür, dass die Gestalt der ersten Geisselglieder auch bei derselben Population variieren kann. Diese Variabilität scheint aber nicht ganz ungerichtet zu sein, da mit der Verlängerung des 3. Geisselgliedes auch die des 4. parallel geht. Ähnliche Verhältnisse konnten in der Variabilität der Gestalt der ersten Geisselglieder auch bei einer ungarischen *Halictus*-Art (*H. tumulorum* L.) festgestellt werden.

Im Gegenteil dazu ist die Variabilität der ersten Geisselglieder bei *A. varians* K. völlig ungerichtet, aber nur auf den ersten Blick. Es gibt Tiere, bei welchen die ersten Geisselglieder entweder alle verhältnismässig kurz oder lang sind, bei der Mehrzahl der untersuchten Exemplare ist aber das 3. Geisselglied am kürzesten. Aus Tab. I. lässt sich entnehmen, dass die in der Gestalt der ersten Geisselglieder auftretende Variabilität zu einer allmählichen Verkürzung des 3. Geisselgliedes führt, also zu einem Zustande, den einige Arten schon erreicht haben.

Tabelle I.

Länge des 2., 3. und 4. Geisselgliedes im Verhältnis zu der der Geisselbreite bei *Andrena varians* K. (Männchen).

2.	3. Geisselglied	4.	Fundort
1,30	1,10	1,15	Boksánbánya
1,30	1,30	1,50	Gyón
1,40	1,60	1,60	Borosjenő
1,50	1,15	1,50	Szalonca
1,50	1,30	1,50	Budapest — Rákos
1,50	1,30	1,50	Budapest — Rákos
1,50	1,35	1,50	Budapest — Rákos
1,60	1,25	1,50	Hadad
1,60	1,30	1,60	Rákospalota
1,66	1,10	1,33	Budapest — Gellérthegy
1,66	1,25	1,60	Rákospalota
1,70	1,50	1,50	Budapest — Sashegy
1,80	1,10	1,33	Budapest — Kelenföld
1,80	1,45	1,70	Budapest — Sashegy



5. Skulptur des Hinterleibes bei *Andrena minutula* K. und *A. ovatula* K. Von *minutula* befindet sich in meinem Untersuchungsmaterial eine grössere Anzahl von Männchen (über 120 Exemplare) von demselben Fundort (Örszentmiklós, Kom. Pest). Die Frühjahrstiere besitzen eine lange, schwarze, die Sommertiere eine dichte, weisse Gesichtsbehaarung, wie dies bei der Beschreibung der einzelnen Generationen schon längst angegeben wurde. Ausserdem macht sich zwischen den beiden Generationen noch ein anderer Unterschied bemerkbar: Bei den Frühjahrstieren ist die Oberfläche des Hinterleibes auf fein gerunzeltem Untergrunde grob punktiert, bei den Sommertieren fehlt dagegen jegliche Punktierung, so dass die Oberseite nur fein gerunzelt erscheint; die Grenze zwischen den beiden Typen ist nicht sehr streng, so dass auch Übergangsformen — wenn auch nur vereinzelt — vorkommen. (Es soll noch bemerkt werden, dass zwischen den beiden Generationen auch in der Gestalt des männlichen Kopulationsapparates ein Unterschied besteht, der aber den Rahmen des für diese Art bezeichnenden Bauplans nicht überschreitet.) Bei den von demselben Fundort stammenden männlichen Exemplaren von *ovatula* (320 Exemplare) besteht zwischen den Frühjahrs- und Sommertieren hinsichtlich der Skulptur des Hinterleibes ebenfalls ein Unterschied, da die Skulptur des Hinterleibes bei den Frühjahrstieren fein gerunzelt und ohne Punktierung ist, bei den Sommertieren dagegen mit ausprägen, groben Punkten versehen ist. Bezüglich der Gesichtsbehaarung ist keine Abweichung von den bei *minutula* bestehenden Verhältnissen wahrzunehmen; die Frühjahrstiere besitzen eine schwarze, die Sommertiere eine weisse Gesichtsbehaarung.

Wie aus der Ethologie dieser Tiere bekannt ist, vollzieht sich die Entwicklung der Sommertiere in einem viel schnelleren Tempo als bei den Frühjahrstieren, bei welchen sie sich auf mehrere Monate erstreckt. Würde nur die eine der beiden Arten in Betracht gezogen werden, so könnte man annehmen, dass das Tempo des Ablaufes der ontogenetischen Entwicklung (schnell oder langsam) die Beschaffenheit der Chitinskulptur der Oberfläche des Hinterleibes beeinflusst. Diese Annahme wird aber schon von vornherein hinfällig, da bei *minutula* die langsam sich entwickelnden Frühjahrstiere eine punktierte Hinterleibsskulptur aufweisen, während bei *ovatula* diese Skulptur bei den sich rasch entwickelnden Sommertieren auftritt. Was nun die anderen Populationen anbelangt, so lässt sich feststellen, dass dieser zwischen den beiden Generationen auftretende Unterschied bei anderen Populationen — wenn es überhaupt besteht — in vielen Fällen gerade entgegengesetzt ist. So besitzen z. B. in der aus Szegetszentmiklós stammenden, aus 12 Tieren bestehenden Kollektion die männlichen Frühjahrstiere von *minutula* eine fein gerunzelte Hinterleibsskulptur mit kaum wahrnehmbarer Punktierung, während die männlichen Sommertiere eine grob punktierte Hinterleibsskulptur zeigen. Das Auftreten einer bestimmten Skulptur bei der einen oder anderen Generation ist also aller Wahrscheinlichkeit nach rein zufällig und nicht durch das Genom der betreffenden Art bestimmt. Über die genetische Grundlage dieser in der Hinterleibsskulptur auftretende Variabilität sind wir noch völlig im unklaren, da analoge experimentelle Untersuchungen, wie z. B. hinsichtlich der Geädermutationen, noch nicht vorliegen.

6. Männlicher Kopulationsapparat. Der männliche Kopulationsapparat zeichnete sich bei den Arten, die auch in Hinsicht der äusseren morphologischen Merkmale nicht variieren, durch eine grosse Beständigkeit aus; kleinere Abweichungen in den Proportionen der einzelnen Teile, sowie in der Gestalt können vorkommen, der für die betreffende Art charakteristische Bauplan bleibt jedoch unberührt. Aber nicht nur bei den konstanten, in ökologischer Hinsicht stenöken, „guten“ Arten des Karpatenbeckens,

sondern auch bei den variablen, ökologisch hypereuryök intermediären Arten bewahrt der männliche Kopulationsapparat seine Beständigkeit; eine Ausnahme bildet nur *Andrena minutula* K. In einem früheren Aufsatz konnte ich zeigen, dass bei der schon oben erwähnten *Andrena*-Population aus Örszentmiklós die Gestalt des Kopulationsapparates bei den Frühjahrstieren bedeutend länger ist als bei den Sommertieren, da die Parameren mehr gestreckt sind, während sie sich bei den Sommertieren einwärts krümmen. Abgesehen von solchen unbedeutenden Schwankungen in der allgemeinen Gestalt des Kopulationsapparates, kommen unter den 60 untersuchten Kopulationsapparaten 2 vor, die vom allgemeinen Grundbauplan deutlich abweichen. Bei sämtlichen untersuchten Kopulationsapparaten von *Andrena minutula* K. besitzt der Aedeagus eine konische Gestalt (Abb. 2 b), nur bei dem einem Exemplar (Örszentmiklós) ist der Aedeagus grundsätzlich verschieden gestaltet, da er an beiden Seiten grosse Seitenlappen trägt (Abb. 2 c) und dadurch eine Gestalt erhält, die für andere Arten charakteristisch ist. Eine ähnliche Form weist der Aedeagus z. B. bei *A. varians* K. (Abb. 2 e) und bei *ventralis* Imh. auf, bei welchen aber diese Form konstant ist. Sonst besteht über die Artzugehörigkeit des betreffenden Tieres kein Zweifel, da die Gestalt der übrigen Teile des Kopulationsapparates (wie Parameral-Platten und Parameren), sowie die der 8. und 9. Bauchplatte sich als völlig identisch mit den Verhältnissen bei *minutula* erwies. Bei einem anderen Exemplar, welches aus Westungarn (Szabóhegy, in der Umgebung von Kőszeg, Kom. Vas) stammt, besitzt der männliche Kopulationsapparat schmale, spitzig zulaufende Parameren und ausserdem macht sich noch in der Form der Parameral-Platten ebenfalls ein Unterschied bemerkbar (Abb. 2 a), der Aedeagus, sowie die beiden letzten Bauchplatten der charakteristischen Gestalt dieser Teile entsprechen. Solche schmale, spitzig zulaufende, zangenartige Parameren weist unter den Arten des Karpatenbeckens z. B. *Andrena bucephala* Steph. (Abb. 2 d) auf, nur sind bei ihr die Parameren verhältnismässig länger.

Obwohl solche abweichend gestaltete Kopulationsapparate nur ausnahmsweise und vereinzelt vorkommen, ist ihre systematische Bedeutung trotzdem nicht zu unterschätzen. Dass sie nicht einfach auf entwicklungsbeschädigende äussere oder innere Einflüsse zurückzuführen sind, also nicht etwa Monstrositäten darstellen, wird durch die völlige Übereinstimmung mit Formen anderer Arten bestätigt. Vielmehr entsprechen sie den Mutationen und weisen darauf hin, dass im Bereiche einer Art, in unserem Falle bei *minutula* K., sprunghaft Merkmale auftreten können (gelappter Aedeagus, zangenartige Parameren), die bei anderen *Andrena*-Arten als charakteristische Artmerkmale wiederkehren. Ein experimenteller Nachweis dieser Auffassung kann bei diesen Tieren selbstverständlich nicht durchgeführt werden; analoge und auch experimentell gut erforschte Fällen sind aber aus dem Reiche der Pflanzen bekannt. H. Burgeff (1941) beobachtete bei dem Lebermoos *Marchantia*, dass sprunghafte und vererbungsfähige Formumprägungen, die bei anderen *Marchantiaceen* als Gattungseigenschaften wiederkehren, keinesfalls als Seltenheiten gelten. H. Stubbe und F. v. Wettstein konnten beim Löwenmaul, *Antirrhinum maius* solche Grossmutationen erzielen, deren Organisationsmerkmale für andere Gattungen der *Scrophulariaceae* bezeichnend sind, so z. B. besitzt *mut. radialis* eine radial-symmetrische Blütenform und nicht eine bilateral symmetrische; ausserdem vermehrt sich die Zahl der Staubblätter auf 5. Dieser Merkmalskomplex ist für die Gattung *Verbascum* charakteristisch. Stubbe und v. Wettstein rechnen so mit der Möglichkeit, dass die Organisationsmerkmale der höheren taxonomischen Typen immer sprunghaft erscheinen, während die geographischen Rassen durch sich summierende Kleinmutationen zustande kommen. Zu der gleichen Schlussfolgerung kam auf Grund

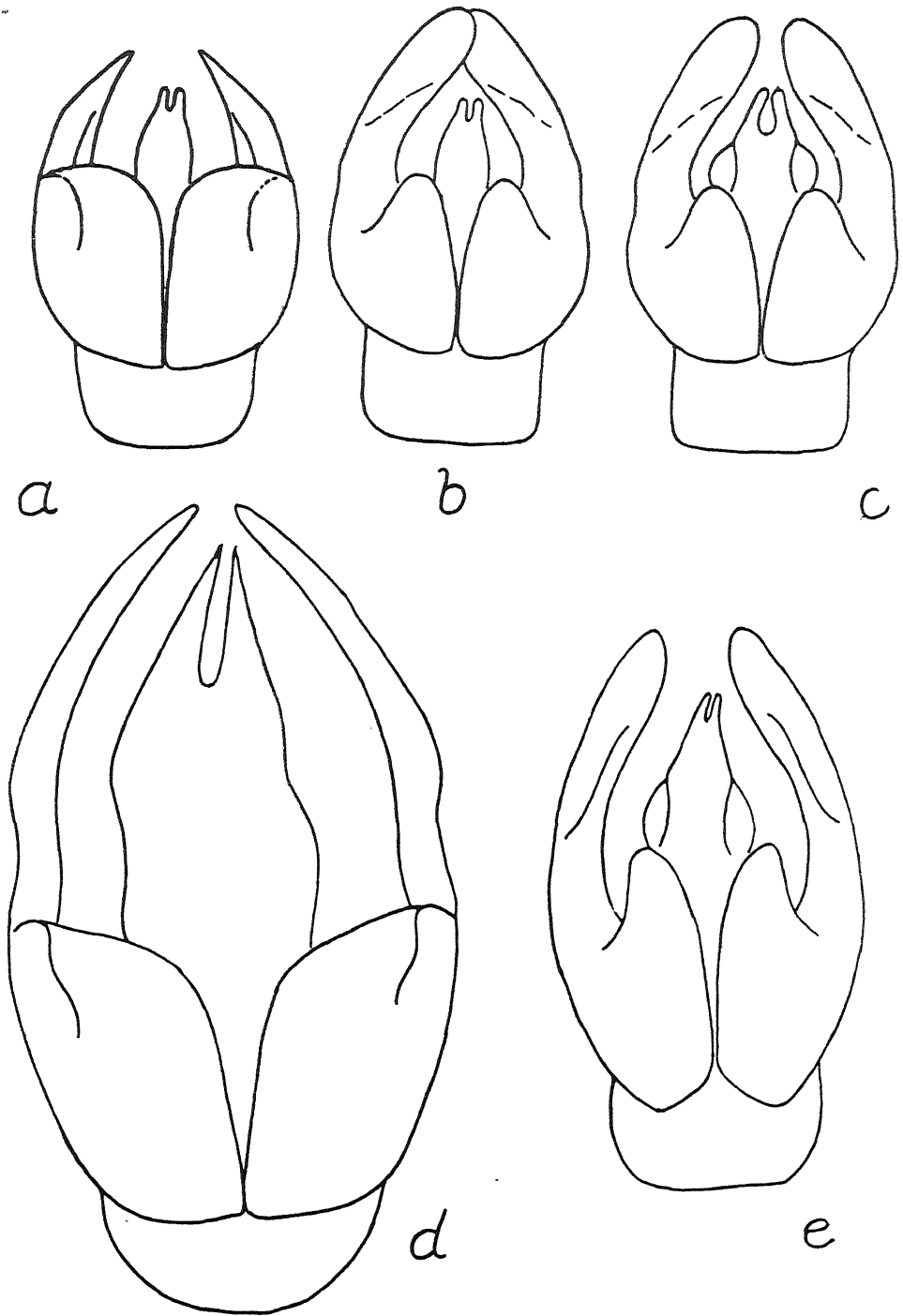


Abb. 2. Männlicher Kopulationsapparat von *Andrena minutula* K. (a, b, c), *A. bucephala* Steph. (d) und *A. varians* K. (e).

eingehender paläontologischer Untersuchungen auch O. H. Schindewolf. Ihm gelang der Nachweis, dass sich z. B. die tiefgreifende Typenumprägung der *Pterokorallen* zu den *Heterokorallen* sprunghaft vollziehen musste, da Übergangsformen zwischen *Hexaphyllia*, dem ersten Vertreter des neuen Typus und anderen Vertretern der *Pterokorallen* nicht bekannt sind (1944—45, p. 130). Das gleiche Prinzip des Typenwandels tritt uns also auch bei der Entwicklung anderer Tierstämme entgegen.

Diese sprunghaft auftretenden Formumprägungen sind nicht ohne jegliche systematische Bedeutung. Man hatte in der Hymenopterologie schon öfters versucht, die Aufteilung der Gattungen auf Grund der Gestalt des Kopulationsapparates durchzuführen (so z. B. L. Méhely bei den Urbienen). Dieser Auffassung nach sollten alle, den gleichen Typus des Kopulationsapparates aufweisende Arten der betreffenden Gattung von derselben Urform abstammen. Auf Grund der oben angeführten Beispiele scheint aber die Richtigkeit dieser Annahme sehr zweifelhaft; es wäre völlig verfehlt, wenn wir die einen für varians charakteristischen Aedeagus besitzenden Exemplare von *minutula* als Vertreter einer selbständigen Art von *minutula* abtrennen und mit *variens* in Verwandtschaft bringen würden. Der männlicher Kopulationsapparat allein kann nicht genügen die Verwandtschaftsverhältnisse einer Gattung zu klären. Diese Erwägungen setzen also den systematischen Wert des männlichen Kopulationsapparates etwas herab, heben aber gleichzeitig seine phylogenetische Bedeutung stark hervor. Sie beweisen nämlich, 1. dass der gleiche Bauplantyp bei verschiedenen, nicht verwandten Arten derselben Gattung auftreten kann und 2. dass die Aufspaltung der Urformen sich dadurch vollzog, dass bei der einen Abstammungsreihe der eine, bei der anderen der andere Typ des Kopulationsapparates zu einem ständigen Artmerkmal wurde.

Wie aus den gesagten hervorgeht, konnte man gerade bei diejenigen Arten (wie *Andrena varians* K., *minutula* K. und *ovacula* K.) eine grössere Variabilität festgestellt werden, welche zu den schwierigsten Gruppen der Gattung gehören. Bei der Trennung der einzelnen Arten stösste man sich gerade in diesen Gruppen auf die grösste Schwierigkeiten. Dieser Umstand lässt sich vielleicht dadurch erklären, dass bei der Beschreibung der einzelnen Arten immer nur einige Exemplare berücksichtigt wurden und dass die Möglichkeit der Variabilität der äusseren morphologischen Merkmale ausseracht gelassen wurde. Obwohl unsere Feststellungen und Erwägungen zur Zeit noch keinesfalls als endgültige Ergebnisse angesehen werden können, lenken sie doch unsere Aufmerksamkeit einen Umstand hin, welcher in der Forschung der Apiden bisher vernachlässigt wurde.

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## THE ORIGIN AND DISTRIBUTION OF APTEROUS ARADIDAE

By Robert L. Usinger

Apterous Aradidae were first collected over one hundred years ago (Brazil, Saint Hilaire, 1815; Gaudichaud, 1833; Mus. Paris) but, due to a curious combination of circumstances, remained unknown until 1941. The first description of an apterous Aradid was by Montrouzier (1864) but the significance of his new genus and species, *Phloeobia sayi*, was overlooked because the apterous condition was indicated only by the rather cryptic statement, "Elytres?". More recently Hemipterists such as Distant, Uhler, Heidemann, Osborn, and Van Duzee saw apterous Aradids because specimens are to be seen in their collections, usually marked as immature. Bergroth not only studied apterous Aradids but went so far as to name at least three new genera and four new species. Specimens bearing these manuscript names have been seen in the museums at Paris and Stockholm. Incidentally, Bergroth's new genera have since been described by others under different names.

N. C. E. Miller was the first modern worker to recognize and describe apterous Aradids, possibly because he collected a specimen himself in Malaya in 1936. Miller followed up his discovery with a careful study of additional specimens in the Selangor Museum and in the British Museum (Natural History) and described seven new species, all belonging to a new genus, *Chelonocoris*, for which he proposed the new subfamily, Chelonocorinae. But here again the extent and diversity of the group were overlooked, despite the fact that *Phloeobia sayi* Montr. and several undescribed genera and species from other parts of the world were to be found in the collections of the British Museum.

Miller's excellent paper prompted me to search for apterous Aradidae in the field and in museum collections. This search was rewarded by the discovery of three new genera, two sent from Brazil by Oscar Monte<sup>1</sup> and one from Australia standing unnoticed in the collection of the late E. P. Van Duzee.

After studying this material it was stated (Usinger, 1941) that, "The recent discovery of apterous Aradidae of the genus *Chelonocoris* Miller was a most remarkable advance in our concept of this group of insects. Localized geographically and exhibiting such remarkable characters, it was unhesitatingly made the type of a new subfamily, Chelonocorinae. Now we find that a new genus, *Notoplocoris*, disrupts the geographical picture and a new genus, *Emydocoris*, destroys any structural homogeneity which the Chelonocorinae may once have had. The nymphs of *Notoplocoris*, furthermore, link this form with typical Mezirinae . . . Thus a polyphyletic origin of the apterous Aradidae is indicated and the subfamily Chelonocorinae is no longer tenable."

Since 1941 a great many apterous Aradids have been discovered, both through field collecting and through a search of museum collections. Two of these were simply descriptions of additional species of the Australian genus *Chelonoderus* (Drake, 1942) and the South American genus *Notoplocoris* (Drake and Harris, 1944 a). Of much more importance, however, were two additional papers by Drake and Harris. One of these (1944 b) extended our knowledge of the *Notoplocoris*-like apterous Aradids of South America by the addition of two remarkable genera, *Asterocoris* and *Allelocoris*, with

<sup>1</sup> Unfortunately the holotypes of *Emydocoris testudinatus* Usinger and *Notoplocoris monteii* Usinger were lost in the mail en route to Brazil in 1943.

stalked eyes and lobulate body margins. The second paper by Harris and Drake (1944) introduced an entirely new type to the apterous Aradid complex. Three monotypic genera, *Acaricoris*, *Glyptocoris*, and *Eretmocoris*, were described from the United States, Brazil and Puerto Rico, respectively. Harris and Drake gave the first key to the genera of apterous Aradidae and indicated by means of the key some of the structural peculiarities of their new genera. More recently, Wygodzinsky in Brazil and Hoberlandt in Czechoslovakia have worked on the apterous Aradidae and now have papers in press.

Meanwhile I have collected one species personally and have discovered in various collections in the United States and Europe over 150 specimens representing at least 17 genera and 64 species. With so much additional material the time seems ripe to test my hypothesis regarding the phylogeny of the group and see what other generalizations may be drawn from a study of this fascinating group of insects.

#### *Acknowledgments*

It is a pleasure to acknowledge the cooperation of C. J. Drake and H. M. Harris, whose material I was permitted to study during a visit to Ames in 1946. The following museum curators assisted in every way during visits to the collections in their charge in 1946 and 1948 or loaned material for study: R. I. Sailer (U.S. National Museum), H. C. Blöte (Mus. Leiden), Jos. Bequaert (Museum of Comparative Zoology), W. R. Swadner (Carnegie Museum), J. N. Knull (Ohio State University), E. C. Zimmerman (B. P. Bishop Museum), and H. Schouteden (Musée du Congo Belge) (Montrousier's types of *Phloeobia*). J. Maldonado-Capriles sent specimens from Puerto Rico and P. Wygodzinsky was kind enough to send his manuscript key, photographs of his new species, and certain paratypes. Finally W. E. China permitted me to study Miller's types and additional material in the collections of the British Museum of Natural History, and R. Jeannel and O. Lundblad assisted in every way during my study of the collections of Paris and Stockholm. To all of these persons and institutions, I wish to express my thanks.

#### *Distribution*

Apterous Aradidae are very nearly tropicopolitan in distribution and at least one species, *Acaricoris ignotus* Harris and Drake, extends as far north as Georgia, Mississippi, and Louisiana. Unlike some of the nearly cosmopolitan genera of macropterous Aradidae (*Aradus*, *Mezira*, *Neuroctenus*, *Aneurys*, *Calisius*), each of the genera of apterous Aradidae is confined to a particular zoogeographic region or to adjacent regions. Thus *Acaricoris* occurs in the southern Nearctic Region and also (unpublished) in the Neotropical Region. *Notoplocoris*, *Asterocoris*, *Allelocoris* and *Emydocoris* are confined to the Neotropical Region, *Chelonderus* is exclusively Australian and *Chelonocoris* is apparently restricted to the southeastern part of the Oriental Region including the Malay Peninsula, Borneo and the Sunda Islands (unpublished). Other genera, as yet undescribed, show a similar pattern.

Apterous Aradids are proportionately more abundant on islands than on continents. Thus 17 of the 56 species known to me are from "oceanic" islands of the West Indies and from Samoa and Fiji. Even the continental species occur principally, according to existing records, on mountains, only 3 out of 18 species for which altitudinal records are available, occurring at or near sea level. The remainder occur at elevations from 500 to 6,000 feet with the average about 3,500 feet.

Habitat preferences are indicated by a few fragmentary observations. Four species in Fiji and Samoa were taken by "beating" and one species was taken "under dead limbs on the ground." In the West Indies one species was found in "decaying wood" and two were collected by means of a Berlese Funnel. I collected *Acaricoris ignotus* beneath very loose bark of a partially disintegrated stump in southwestern Georgia. It is difficult to draw any conclusions from these scattered and rather conflicting records.

### *Origin and Evolution*

As mentioned above, it seemed obvious in 1941 that the apterous Aradidae were polyphyletic in origin. This observation has been confirmed by additional material, especially by the West Indian and Pacific genera and species related to *Carventus*. Until 1944, all of the known apterous Aradids were related to the cosmopolitan genus *Mezira* or to certain bizarre offshoots from that genus (*Barcinus*, *Phyllotingis*, etc.). This group of genera, for which I propose the new tribal name, *Mezirini*, is characterized by the presence of lateral scent gland openings which extend to the outer edges of the mesopleura where, in some cases, they may be seen from above. On the other hand, *Carventus*, *Proxius*, *Acaricoris*, and some other genera to be described later have the scent gland openings so obscure that they are difficult to see, hidden in a crease behind the middle coxae and the body is covered with a peculiar incrustation. The new tribal name *Carventini* is here proposed for this group.

The apterous *Mezirini* are polyphyletic, judging by the very diverse types which are confined to particular areas of the world. However, it is difficult to prove that these types originated from different macropterous Aradids, since they all have the same basic structural characteristics. On the other hand, the apterous *Carventini* show striking proof of polyphyletic origin because it is obvious that they must have evolved from macropterous *Carventini* rather than from *Mezirini*.

The apterous *Carventini* also show evidence of heterogeneity *inter se*. This tribe is predominantly apterous with 28 apterous species and only 17 macropterous species known to me. In America I know of only one macropterous species (*Carventus mexicanus* Bergr.) whereas there are twenty apterous species before me. Whether or not these apterous species were derived directly from *Carventus* is uncertain in America but a parallel situation in Samoa and Fiji is suggestive. On the island of Upolu, Samoa, at about 2,000 feet elevation, E. C. Zimmerman found typical *Carventus* with fully developed wings and trilobed anterior pronotal angles, a wingless *Carventus* with perfectly developed scutellum and a single broad anterior pronotal lobe, and an apterous species with no trace of scutellum and with the entire thorax fused much as in the American apterous *Carventini* but with important differences in detail. Each of the Samoan species differs not only in degree of wing development and thoracic structure, but also in head characters and male and female genitalia.

It is interesting to note that a comparable series, involving different species, occurs on Viti Levu, Fiji, where, at 500 feet elevation E. C. Zimmerman took a winged *Carventus* with trilobed anterior pronotal angles and a typical apterous species. However, the intermediate type in this case has broadly lobed anterior pronotal angles but fully developed wings.

It should be emphasized that the apterous species which were presumably derived from Samoan and Fijian *Carventus* differ considerably from apterous *Carventini* in America and will need to be referred to separate genera. This is not an unexpected



result of the evolution of separate offshoots, even though the two branches arose from the same large, world-wide genus.

### *Types of Wing Polymorphism in the Aradidae*

Wing polymorphism is common in the Aradidae and especially in the genus *Aradus* where various degrees of brachyptery, microptery and stenoptery occur (Parshley, 1921). *Mezira* exhibits varying degrees of brachyptery in undescribed species from Cuba, Java, and elsewhere and, as described above, a Samoan *Carventus* is wingless but retains a complete scutellum as in macropterous forms. This condition is little more than an extreme case of brachyptery in contrast to the completely fused thorax of the truly apterous Aradidae. What, then, is the nature of aptery in the Aradidae and what factors in their environment or heredity might cause such a phenomenon?

First as to the nature of the apterous condition. The first species of apterous Aradidae were open to suspicion because of the possibility that macropterous specimens might exist and might have been described previously under other names. Such a situation occurs in the Naucorid genera *Aphelocheirus* and *Cryphocricos* and, of course, in many water striders (*Gerris*, *Microvelia*, *Rhagovelia*). Only time and additional material could lessen the likelihood of finding macropterous forms of these species. There are still less than two hundred specimens of apterous Aradidae known but even this small sample may be considered significant because specimens have turned up from all parts of the new and old world tropics without a single instance of specific identity with macropterous forms which occur in the same territory. Specific identity in this case is taken to mean identity of head and antennal characters and identity of the very reliable characters of the male and female genitalia. In the absence of any cases of specific identity of apterous and macropterous forms we may assume that aptery, once it is achieved in a group, becomes fixed. Here again we have a parallel in certain groups of water striders. *Halobates*, *Halovelia* and *Trochopus* are the permanently apterous counterparts of *Metrobates*, *Microvelia* and *Rhagovelia*.

Apterous Aradids resemble nymphs superficially and this might lead one to infer that such forms are neoteinic. On the contrary, close comparison of nymphal and adult structures shows no evidence of arrested development except, of course, in the wings themselves. And even the wings develop as distinct pads in late instars (*Notoplocoris*) but disappear in the final transformation. Hence apterous Aradids are adults in every sense of the word rather than macropterous forms whose development has been arrested or slowed down. This is equally true of marine water striders, the apterous adults being entirely different from the nymphs and possessing a full complement of adult structures.

The causes of wing polymorphism in general and aptery in particular have been subjects of great speculation since the time of Darwin and wing atrophy through disuse is a Lamarckian concept. More recently Darlington (1943) analysed the "Carabidae of Mountains and Islands" with special reference to the evolution of isolated faunas and the atrophy of wings. He found a positive correlation between wing reduction and occurrence as geophiles on islands or isolated mountains. He concluded that the "Occurrence of—winged Carabidae in nature is correlated with factors which tend to reduce usefulness of flight but which do not necessarily make it harmful" . . . .

Many species of the genus *Aradus* engage in a spring dispersal flight which coincides with that of other subcortical insects (Linsley and Usinger, 1942, 1944). Other species of *Aradus* must be more sedentary because, as noted above, such species as *Aradus*

*cinnamomus*, *heidemanni*, etc. are brachypterous or stenopterous. Mezirinae are seldom if ever taken in flight although the macropterous forms are apparently capable of flight. Presumably they need to fly from one microhabitat to another, to establish themselves in colonies on fungi, usually beneath bark. But if flight is necessary or even just useful as indicated above, then why have some Aradids lost their wings altogether? A possible answer is suggested by Darlington's Carabid paper. Twenty-two species of Aradidae are known (some undescribed) from the main islands of the West Indies. Of these, 10 are macropterous, 1 is brachypterous, and 11 are apterous. Twenty-three species are known from the islands of Samoa and Fiji of which 15 are macropterous, one micropterous, and 7 apterous. Forty-four species are known from the mainland neotropical fauna of Panama, 42 of which are macropterous and 2 of which are apterous. Thus it would appear that in these areas, each of which has been collected for Aradids with about equal intensity, the apterous condition predominates on islands and the macropterous condition is overwhelmingly the rule in continental lowlands. It has also been shown that a significant proportion of the apterous species for which altitudinal data are known occur in mountainous areas from 500 to 6,000 feet. Whether or not they are also geophiles remains for future collectors to determine but it is interesting to note that two of the West Indian species were taken in a Berlese funnel, presumably but not necessarily from the ground.

#### Summary

The apterous Aradidae were first recognized as such in 1936, although the first species was described 72 years before and the first specimens were collected a century earlier. Nearly 200 specimens representing at least 17 genera and 64 species are now known from all parts of the tropics. The genera are confined to particular zoogeographic regions or to adjacent regions.

The apterous Aradidae are polyphyletic, with several genera in each of the two tribes, Mezirini and Carventini, which are herein proposed as new tribes. It seems likely that the apterous Mezirini are polyphyletic and it seems certain that the apterous Carventini arose at least twice, one group being American and the other Fijian and Samoan. In the latter case a sequence of three steps from macroptery to aptery is described, based upon three species collected from a spot at 2,000 feet elevation on Upolu, Samoa, and another spot at 500 feet on Viti Levu, Fiji.

Aptery in the Aradidae is compared with that in water striders and the opinion is expressed that the apterous condition in the Aradidae is fixed just as it is in *Halobates*, *Halovelia*, and *Trochopus*. Also as in the apterous water striders it is felt that the structural modifications are not neoteinic, but on the contrary, represent special developments of adult characters. Evidence is advanced in support of the theory that aptery is favored by isolation on islands or mountains or both.

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## BEES AND WASPS OF THE MALAY ARCHIPELAGO, AND SOME NOTES ON TAXONOMIC ENTOMOLOGY IN GENERAL

By J. van der Vecht

When almost a hundred years ago the well known naturalist A. R. Wallace started on his collecting trips in the East Indian islands, only a small number of bees and wasps was known from this part of the world.

Of the five large families of the aculeate Hymenoptera (*Scoliidae*, *Sphecidae*, *Pompilidae*, *Vespidae* and *Apidae*) approximately 120 species had been described before 1850, mostly by Linnaeus, Fabricius, Guérin, Lepeletier, Dahlbom and some others. Shortly afterwards, F. Smith added another 55 species in his catalogues of Hymenoptera in the British Museum.

The importance of the collections made by Wallace is demonstrated by the fact that no less than  $\pm 330$  species were described from his material as new to science. Wallace's activities in this field could have resulted in a very substantial addition to our knowledge, but unfortunately Smith described the new species so briefly and inadequately, that most of them had to be listed by later authors, who had no access to the types, as "unidentified". In the genus *Chlorion* (*Sphex* auct.) for instance, Smith described 54 new species, but when Kohl wrote his monograph of this genus, only 29 of these could be recognized with sufficient certainty.

The next author who described numerous species of bees and wasps from this area was Peter Cameron. Besides large collections from India, Cameron received much material from Borneo (Shelford collection) and from some Dutch expeditions to New Guinea. Cameron's work was perhaps even more unsatisfactory than that of his predecessors; many of his names have already been sunk into synonymy and there is little doubt that others will eventually meet with the same fate. Some of his types have been examined and identified by later authors, but it will take a long time before all the problems created by this author will have been solved.

The same is more or less true for the work of the German apidologist Friese, who published many descriptions of Oriental and Papuan bees in the early years of the present century. Although Friese composed a few comprehensive works on the bee-fauna of Java and New Guinea, the identification of bees from these islands remains as yet an extremely difficult problem.

In later years some genera of bees and wasps have been treated in monographs, but only the family *Scoliidae* has undergone a complete revision (Betrem, 1928). For the major part of the genera no keys are available, and our present knowledge of the species of these genera consists exclusively of separate and mostly inadequate descriptions, which are scattered over an enormous number of scientific serials and expedition reports.

The unsatisfactory state of our knowledge has already led to many unhappy consequences. It has caused lack of stability in nomenclature and confusion in many other respects. Misidentifications are of common occurrence and become particularly troublesome when genotypes are involved. A few instances may be given.

In 1904 Ashmead identified a Philippine Pompilid wasp as *Salix bipartitus* Lep., a species originally described from Java, and made it the type of a new genus,

*Pseudosalinus*. Recently I have found this identification to be incorrect; the true *bipartitus* apparently does not even occur in the Philippines. Similarly the type of the genus *Parasalinus* Banks, erected in 1934, was incorrectly regarded as identical with a species previously described by F. Smith. Such mistakes could have been avoided, if the old species had been better known.

It is interesting to consider the question: What part of the existing wealth of species of the Indonesian islands has been described up to the present?

According to my card-index the numbers of species described in some families of wasps is approximately as follows: *Sphecidae* 250, *Psammocharidae* 190 and *Vespidae* 290 (total 730). These same families are represented in our collections at Buitenzorg by resp. 185, 185 and 90 (total 460) species from Java alone. In view of the fact that in many other groups the number of species occurring in Java is estimated to be only 20—25 % of that in the whole Archipelago, we may safely assume that the total number of representatives of these wasp families in this area will be about 2000, so that only 30 to 40 % of these have been described. In the bees this percentage is probably somewhat higher.

Although there are undoubtedly considerable numbers of undescribed species in the existing collections, it is evident that to obtain a reasonably reliable picture of the bee- and wasp-fauna, much more collecting will be necessary. In this connection a few words may be said on the habitat of these insects.

Long ago all islands in the Archipelago were almost entirely covered with dense tropical forests. Through the activities of man a large part of these forests has now disappeared, to be replaced by cultivated crops, secondary vegetation and fields of lalang grass (*Imperata cylindrica* Beauv.). This process has gone extremely far in Java, where the population is much denser than anywhere else in Indonesia. Lowland virgin forests are at present restricted here to a few isolated and limited areas, and even on most of the mountains the primary forests have disappeared below a level of 4000—5000'.

A comparison of the bee- and wasp-fauna of the primary vegetation with that of the cultivated areas shows interesting differences. The original forests are relatively rich in species, but many of these are scarce and represented by only few individuals. For the entomologist, collecting in such places is always a fascinating experience, for every excursion may reward him with unexpected discoveries. Even in Java, where my friends and I have spent many days in collecting in various localities, new species continue to turn up. In our collections there is still a very considerable number of species represented by only a single specimen.

In the cultivated areas the fauna is much poorer, so far as the number of species is concerned. Many species disappear entirely when the virgin forests are cut down. Others are able to survive in secondary vegetation, or have adapted themselves to conditions existing in plantations of crops, or in gardens in cities and villages. Various species of bees, such as *Xylocopa*, *Nomia*, *Ceratina*, *Halictus* and others, are nowadays common visitors of flowering plants which have been imported during the last few centuries. Many wasps make use of the protection against the heavy tropical rains, offered to them by human constructions. Clay cells of *Sceliphron* and *Pison* are frequently found in houses, under bridges, etc. Certain species of *Pison*, *Trypoxylon* and *Rygius*, formerly perhaps inhabitants of abandoned tunnels of woodboring beetles, have now become a nuisance in houses, where they store their prey in such places as key-holes, the bands of books or even in gasburners in the laboratories. Many

of these "domesticated" species are probably much more numerous at present than they have ever been before.

It is obvious that further collections should be made especially in the areas still covered with original vegetation. In certain islands such areas are already scarce or entirely absent, and in the latter case our faunistic data will remain incomplete forever.

This is certainly regrettable, for from a zoogeographic point of view the distribution of the East Indian bees and wasps promises to be extremely interesting. Unfortunately our present knowledge of most of the groups is still too incomplete to present a reliable basis for conclusions in this field. The only group, which has been studied in this respect, is the family of the *Scoliidae* (Betrem, 1928), but even in this group the distribution area of many species is only imperfectly known.

In former years so many species have been either incorrectly labeled or identified, that the picture of the distribution of the described species, as it appears to us from the existing literature, is not only incomplete, but in many respects even definitely incorrect. A few examples may illustrate this. In old collections, Java is often given as the place of origin of specimens, which actually were collected in other islands. Consequently, previous authors have given little attention to the important differences existing between the faunas of Sumatra and Java. Although these islands are separated by a strait, which at its narrowest point is only three miles wide, there are several species of bees and wasps of common occurrence even in the cultivated areas of Sumatra, which have never been found in Java. The nocturnal wasps of the genus *Provespa*, *P. anomala* (Sauss.) and *P. nocturna* v. d. Vecht, frequently come to the light in houses in Sumatra, also in the extreme south, but nevertheless they are absent in Java. In Sumatra, there are at least six species of the genus *Vespa*, but in Java we have never found any other species than *V. tropica* L., *V. analis* F., and *V. velutina* Lep. Until quite recently (Bequaert, 1936, van der Vecht, 1935, '36) these differences were not apparent from the literature: Smith (1871) for instance has erroneously recorded *Provespa anomala* Sauss. (= *P. dorylloides* Sauss.), *Vespa affinis* F., *V. alduini* Guér. (the Moluccan subspecies of *V. affinis*) and *V. bellicosa* Sauss. (recte *V. luctuosa* Sauss., subsp. *bellicosa* Sauss.) from Java, and there is little doubt that similar errors have been made in other genera. A critical revision of old locality-records is therefore urgently desired.

A better knowledge of the taxonomy of the Indo-Australian bees and wasps would have a very stimulating effect upon the study of the extremely interesting life histories of these insects. Many observations on this subject have remained unrecorded or are of little scientific value, because the insects involved could not be identified with certainty. The relations between bees and flowers in the tropical forests are still little known and should be studied by botanists as well as entomologists.

When we now consider the question, what are the main obstacles for further progress in this field, we touch upon a subject which is not only of importance to this particular group of insects or to this particular part of the world. As time goes on, the study of the insects in general of all countries, where faunistic entomological research has started at a relatively late date, will become more and more difficult on account of the impossibility to recognize with certainty a large part of the previously described species.

Deliberate attempts to solve this problem become increasingly urgent. The number of entomologists working far away from the old centres of insect taxonomy is growing rapidly. Many "exotic" countries, the insect fauna of which was formerly explored

only by European travellers, have now their own institutions for research in general and economic entomology. The investigations of their workers are considerably impeded by the fact that many of the insects, formerly described from their countries, cannot be identified without a study of the types in the Museums in Europe or elsewhere.

These entomologists are generally not in a position to travel through the world with the special purpose of studying the insects formerly collected in their country. On the other hand one cannot expect them to wait till the understaffed Museums abroad will have produced monographs of all exotic insects. So either they will disregard the "old" species, or they will do guess work and consequently make errors. It is needless to say that both courses are apt to add to the existing confusion.

I have come to the conclusion, that it would be extremely helpful if specialists would particularly concentrate their attention to studies that may contribute to the elimination of the burden of inadequately described and erroneously determined species.

Everybody knows that this is a difficult task and I will mention only a few of the problems inherent to such work. It involves the study of many types, scattered over a large number of museums. Some of these museums do not lend out types. Many of the earlier types are not marked as such, and in other cases more than one specimen may bear a "type"-label. As the late Cockerell pointed out with regard to the bee fauna of Africa: "Some authors, such as Friese and Cameron used the term type to cover all the specimens, assumed to be of a single new species. It has since appeared that in several cases these series were composite, and there is great need to go over the collections and designate holotypes. This must involve studying the descriptions with the object of determining which insect was actually used by the author." Horn and Kahle have indebted all taxonomic entomologists by the publication of their paper: "Ueber entomologische Sammlungen", yet specialists still have often considerable difficulties in locating the types of the species they want to study. Finally it must be said that museum-authorities and -workers are generally insufficiently interested in the question, whether or not the species of which they possess the types are adequately described in the literature.

It is certainly not always easy to say whether a certain description is adequate or not. But anyone taking the trouble to compare a description of a wasp by Smith or Cameron with that of a related species by Kohl will easily notice the difference. The requisites of a good description have been aptly summed up by Bequaert in a short paper, read as part of a symposium at the New York meeting of the Entomological Society of America in 1928: descriptions should be reasonably complete, both accurate and clear, and comparative or analytic. If the existing descriptions of the Indo-Australian bees and wasps could be supplemented along these principles, the way would be paved for future research on their taxonomy, distribution, bionomics, ecology, etc.

In conclusion, I should like to offer a few suggestions which perhaps might help to solve some of the difficulties outlined above:

1. Museum specialists should pay more attention to the status of the valuable old material in their collections. They should prepare critical inventories of the exotic specimens they regard as types or at least suspect to belong to typical series.

2. They should consult specialists with regard to the desirability of having the types of old species redescribed, and where necessary, they should take all possible

steps to have the existing descriptions (and figures) adequately supplemented by competent entomologists.

3. Specialists should prepare annotated lists of old—and in some cases also of more recently described—species which in their opinion cannot be identified with certainty from the existing descriptions alone. Such lists might be published in an international entomological journal, but in view of their temporary value it would perhaps be more desirable if they could be distributed in processed form to all Museum-authorities by a Museum in the country of the specialist.

4. Museum-authorities should regard it as a duty of the first order to study such lists and to supply the desired information and they should cooperate in every possible way with the specialists concerned.

5. Fellowships should be made available to enable specialists to supplement and correct the descriptions of former authors, whose work has been incomplete or inaccurate as judged by present standards.

6. As regards the bees and wasps of the Indo-Australian area, a thorough revision of the species described by Smith, Cameron, Friese and Cockerell is a necessary condition for fruitful future research on this subject.

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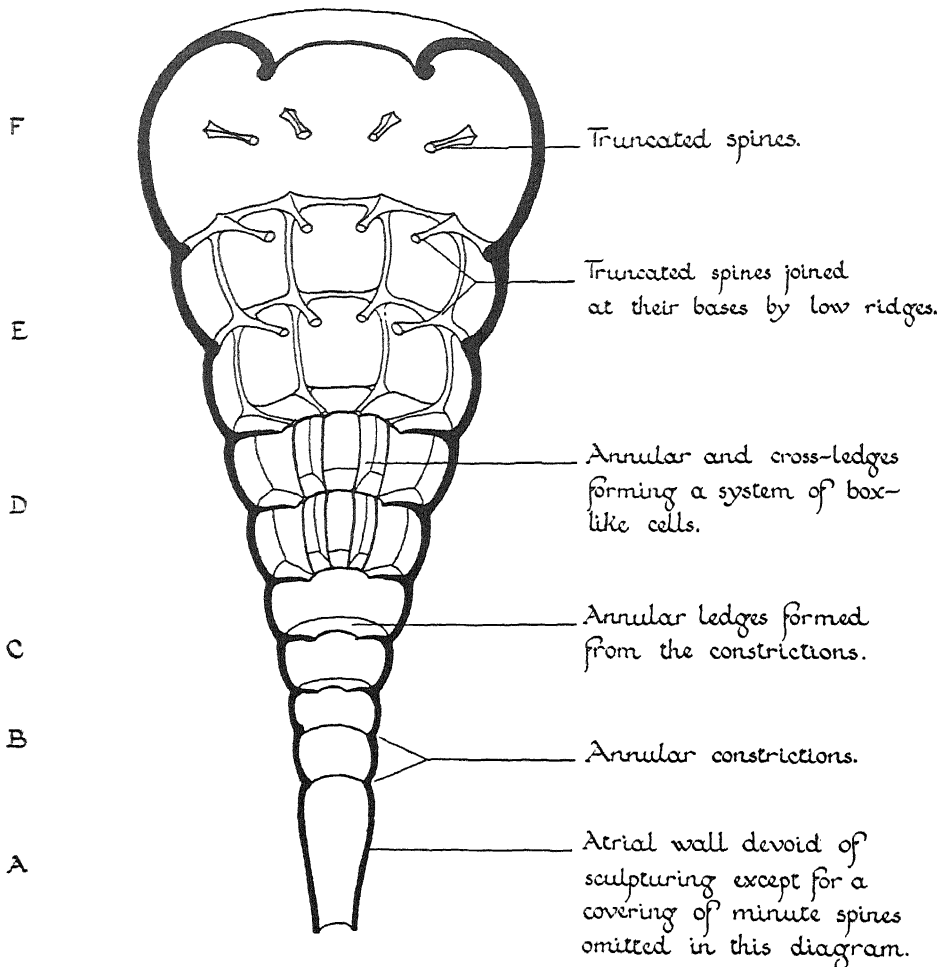


## ORTHOGENESIS IN THE ANOPLURA

By J. E. Webb

Recent work on the evolution of the Anoplura seems to show that many of the structures used in the classification of these insects have developed independently (see Webb 1946, 1947, 1948 and 1949). This is due not so much to parallel evolution brought about by similar environmental stimuli causing similar mutations to be selected because of their survival value, but rather as a result of inherent tendencies in lice of related groups to develop certain structures in a definite direction independently of one another. The theory postulating that genes, possibly under suitable stimulation, may tend to mutate in a certain way, thus producing a series of structures in what may be termed a predetermined sequence, is known as orthogenesis. It is usually extremely difficult to demonstrate that orthogenesis has taken place, as most lines of evolution, which may be the result of orthogenetic development, are also explicable on the grounds of suppression by natural selection of all forms except those showing modifications of a particular type. It is only when two similar lines of development, which have no particular survival value or else may be definitely disadvantageous, occur in related groups of animals that an explanation based on natural selection seems inadequate and one involving orthogenesis more probable.

In the biting and sucking lice, a number of characters appear to have developed orthogenetically. One of the best examples of this is seen in the development of the spiracles in the Trichodectidae and the Siphunculata. Whereas the spiracles of the Siphunculata have been worked out in considerable detail, those of the Trichodectidae have received only a limited treatment, nevertheless, sufficient is known of the latter group to enable a comparison to be made. In a series represented by sucking lice from certain rodents and from Ferungulata, it has been shown (Webb, 1946, 1947, 1948 and 1949) that, as the spiracle evolves, the size of the atrium increases and the atrial wall undergoes a number of convolutions resulting in a definite pattern of sculpturing (see fig. 1). First, the atrial wall becomes annularly constricted to form ledges (fig. 1, B and C), next these become joined by cross-ledges to form a honeycomb of cells (fig. 1, D) and finally the ledges disappear to a varying degree leaving their points of junction projecting into the atrium as chitinous processes (fig. 1, E and F). Now, in the Trichodectidae, the spiracles, apart from being almost exactly similar in construction, develop atrial sculpturing in exactly the same manner. The spiracles develop annular ledges (Webb, 1946, fig. 50) which become joined by crossledges (Webb, 1946, figs. 43 and 46) and finally the intermediate portions of the ledges begin to break down leaving chitinous filaments projecting into the atrium where the ledges joined one another (Webb, 1946, figs. 30—32). So similar is the development of the spiracles that, if the spiracle of say *Trichodectes canis* is compared with one from *Linognathus vituli* (Webb, 1946, figs. 30—32 and 157—159) they would be accepted as spiracles of species of the same genus. Now any connection between the Trichodectidae and the Siphunculata can only be very distant, the groups having been distinct from at least the Cretaceous period and possibly earlier at which time the spiracles of the Siphunculata, at least, and almost certainly those of the Trichodectidae, too, were not only very small but were also devoid of atrial sculpturing. We must conclude, therefore, that the evolution of the spiracles in *Trichodectes canis*



Diagrammatic longitudinal section through a hypothetical spiracle of an anopluran showing the development of the sculpturing on the internal surface of the atrial wall

Fig. 1.

and *Linognathus vituli* has been entirely separate and that the development of almost identical structure has been achieved independently from simple beginnings.

It may be argued that the agreement between the structure of the spiracles in Siphunculata and Trichodectidae may have arisen as a result of their sharing the same environment. This is true to the extent that both biting and sucking lice are found together on the same host animal. Such an argument would be valid if the structures involved were purely adaptive. Here, although the development of the spiracles is in a sense adaptive, the most efficient form of spiracle evolved in the series has been arrived at by a circuitous route when it could have been developed directly from the basic structures already in existence. Furthermore, as has already been stated, it appears that the method of development adopted was identical in both Trichodectidae and Siphunculata. Now the atrium of the spiracle appears to serve only one function, that of the removal of dust from the inspiratory air-stream. This filtering mechanism is achieved in a spiracle of the type under discussion mainly by the passage of air into a comparatively large chamber through a small aperture leading from the exterior. Thus, while passing through the atrium, the velocity of the air-stream falls considerably and, possibly at the same time, swirling movements occur and dust previously held in suspension by air movement is deposited on the walls of the atrium (see Webb 1945). One of the evolutionary trends seen in these spiracles is the increase in the size of the atrium. This fulfills the double purpose of increasing the efficiency of the atrium as a deposition chamber and providing a greater volume in which larger and larger quantities of dust may accumulate without seriously impairing the efficiency of the atrium or, indeed, blocking it entirely. In addition, some mechanism is required to hold the dust as it accumulates on the atrial wall. If the atrial wall were entirely smooth, then dust collected there might be expected to find its way eventually into the trachea merely by the action of the insect's body movements. This need is fulfilled in both the Siphunculata and the Trichodectidae by the coating of the atrial wall with a sticky fluid secreted by a spiracular gland (see Webb 1946), and by the provision of irregularities on the internal surface of the atrium in between which dust can collect. It is the form of these irregularities which is of interest at the moment. In the simplest, smallest and presumably most primitive spiracles in the Siphunculata, the atrial wall is covered with minute projections for holding dust accumulations. Now, theoretically, it would be expected that one of the most efficient forms of dust trap on the atrial wall would be a series of long spines projecting from the atrial wall and coated with a sticky fluid. Spines of this type would not subdivide the atrium and therefore reduce its effective volume as a deposition chamber for air could pass freely between them. At the same time, however, the spines would serve not only to filter larger particles from the air-stream but also to anchor the dust accumulations to the atrial wall as the deposit became thicker and thicker, right up to the point when the entire space between the spines is filled with dust and the volume of the atrium so reduced that it can no longer serve either as a direct filter or as a deposition chamber. The form of atrial sculpturing in which the atrium is either subdivided by annular ledges or covered with box-like cells when the annular ledges are joined by cross-ledges, should be less efficient than a series of spines simply because the ledge-system reduces the effective volume of the atrium and forces air to pass in a comparatively swiftly-flowing stream down the ledge-free central channel. If this disadvantage is overcome by a still greater increase in atrial volume thus forming a large open central channel, the atrium remains less efficient than

one using spines to hold the dust as, in the absence of spines, there is no direct filtering of air. The filtering effect of spiracles with either ledges or spines is well seen in the far greater quantities of dust which are almost always found in the latter in comparison with the amounts in spiracles even with the most highly developed ledge system. It is significant, too, that the most advanced spiracles in the Siphunculata possess atrial spines but only after first developing a series of ledges. The efficiency of the atrial spines as a filtering mechanism is demonstrated elsewhere (Webb 1946, figs. 189 and 190). The method of developing these spines is most unusual, for, after a series of box-like cells is formed on the atrial wall from annular and cross-ledges, these are then broken down leaving only the points of junction of the ledges projecting into the atrium. As the small primitive spiracle in Siphunculata starts with a covering of minute spines, it would surely have been more direct to have developed these as the atrium increased in size rather than to have evolved an entirely new type of sculpturing and later to modify that to reach the same end.

The point of importance, here then, is that, in both the Siphunculata and the Trichodectidae, the evolution of the spiracle is not necessarily adaptive as what would appear to be an easier, more direct method of reaching the most efficient type of atrial sculpture from a basal form already laid down in the small spines of primitive spiracles is discarded in favour of the same more devious route in both groups. It is suggested, therefore, that the evolution of spiracle structure in the Siphunculata and the Trichodectidae is orthogenetic and that the development of a sequence of types of atrial sculpture in both groups of lice is not adaptive in so far as it is not due to the selection by environmental conditions of favorable novelties from a variety of chance mutations. There is evidence, too, to suggest that this is not an isolated instance for, to a more limited extent, orthogenesis seems to have occurred in the development of spiracle structure within the Siphunculata themselves. The genera *Haematopinus*, *Microthoracius*, *Ratemia* and a few species of *Linognathus* such as *L. fractus* and *L. hippotrugi* possess spiracles of a similar advanced type with atrial processes formed from the breakdown of a ledge-system, and yet it can be shown (Webb, 1949) that these lice probably diverged at an early date from an ancestral form whose spiracles must have had a more or less complete ledge system. It is clear, then, that the breakdown of ledges to form spines, in these genera and species, has occurred independently at least four and probably more times as each species of *Linognathus* with atrial spines or processes has almost certainly acquired them separately.

The development of cross-ledges joining the annular ledges in the atrium appears to be connected in some way with the size of the spiracle in the adult. The sucking lice from rodents almost all possess small spiracles, that is up to about  $20\ \mu$  diameter at the widest part of the atrium, with a characteristic type of sculpturing in the form of a series of annular ledges only. In *Prolinognathus* from hyrax, the thoracic spiracle is rather larger than those commonly found in lice from rodents while the abdominal spiracle is of the same order of size as those from that group (Webb, 1947). In the thoracic spiracle of that species cross-ledges are present in the distal region only while in the abdominal spiracle they are absent. It seems, then, that the thoracic spiracle is just over the threshold of size at which cross-ledges are formed. In *Linognathus*, the spiracles of almost all species are considerably larger than  $20\ \mu$  diameter and possess both annular and cross-ledges throughout. The series of species of *Linognathus* from Bovidae and Giraffidae with the exception of *L. fahrenheiti*, *L. hippotrugi* and *L. ovillus*, (see Webb, 1949) have spiracles of much the same type but covering a

considerable range in size. Now the abdominal spiracles of some of the species in this series, notably *L. breviceps*, *L. gnu* and *L. damaliscus* are very small not greatly exceeding  $20\mu$  in diameter and here the cross-ledges are noticeably few in number or are absent entirely. Although we cannot be certain that the small abdominal spiracles in these species of *Linognathus* are not primitive, it seems more probable that they are derived from a more normal type of linognathoid spiracle with a comparatively large number of cross-ledges by means of a process of reduction. Thus, it would seem that, when the size of the atrium reaches a low limit of about  $20\mu$  diameter, the cross-ledges disappear and the spiracle reverts to the type common in some rodent-lice. To illustrate this point, the diameter of the distal region of the abdominal spiracle of each species in the series was measured and the number of cross-ledges on the atrial wall in that region counted (see table I). A graph was drawn showing the relationship between atrial diameter and number of cross-ledges (see fig. 2) and it was found that the points plotted fell more or less into a straight line with the number of cross-ledges increasing regularly as the diameter increased above  $20\mu$ . Thus annular ledges may be present in spiracles of under  $20\mu$  in diameter but not cross-ledges. As soon as the atrium reaches a size above  $20\mu$  diameter, cross-ledges begin to appear and increase in number with spiracle size. Similarly, should the size of the spiracle decrease for any reason, then the cross-ledges become fewer in number and finally disappear at a diameter of about  $20\mu$ . This relationship, however, seems only to apply to adults of different species within a related series. In the spiracles of the nymphs of *L. pedalis*, there is very little variation in the number of cross-ledges in the distal bulb of the

Table I

Species of <i>Linognathus</i>	Diameter in $\mu$ of dis- tal region of abdominal spiracle	No. of cross-ledges in distal region of abdominal spiracle
<i>pedalis</i> (adult)	45	24
» (3rd nymph)	36	21
» (2nd nymph)	31	20
» (1st nymph)	25	20
<i>stenopsis</i>	27	14
<i>africanus</i>	30	14
<i>gazella</i>	40	24
<i>breviceps</i>	20	0
<i>angulatus</i>	27	12
<i>aepycerus</i>	25	4
<i>tibialis</i>	25	4
<i>pithodes</i>	27	8
<i>lewisi</i>	34	12
<i>gnu</i>	22	2
<i>damaliscus</i>	21	1
<i>taurotragus</i>	35	16
<i>fractus</i>	40	22
<i>limnotragi</i>	43	26
<i>brevicornis</i>	43	30

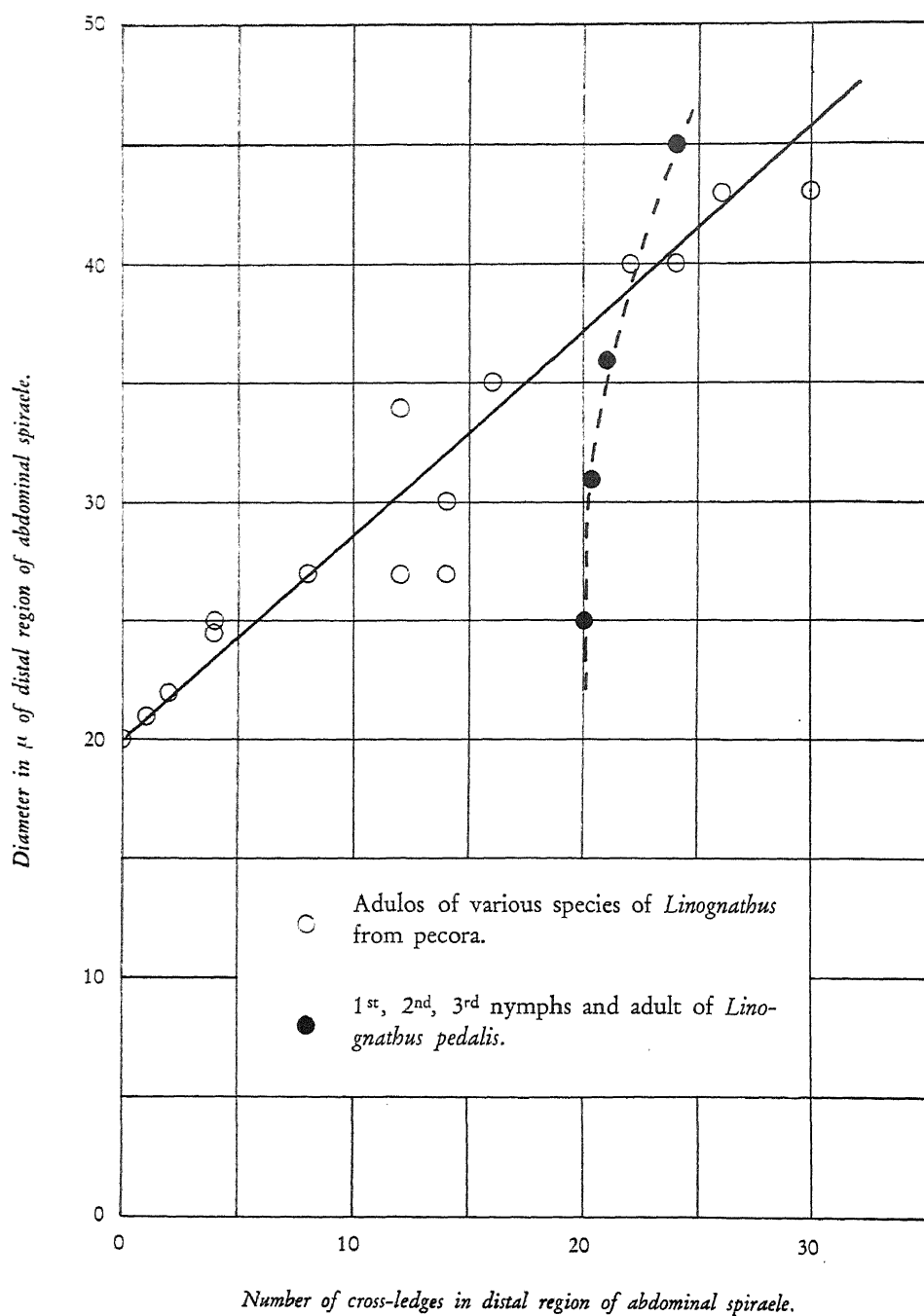


Fig. 2.

atrium from one instar to the next although there is a considerable increase in diameter (see fig. 2). There are as many cross-ledges in the abdominal spiracle of the 1st nymph, which is  $25\ \mu$  in diameter, as would be expected to be found in an adult spiracle of  $38\ \mu$  diameter in the *Linognathus* series under discussion. Clearly then the formation of cross-ledges only when a spiracle exceeds  $20\ \mu$  in diameter is not due to any mechanical impossibility of forming cross-ledges in a spiracle of that size, for the spatial arrangement of ledges in the 1st nymph spiracle is so close that there is ample room in a spiracle of less than  $20\ \mu$  diameter to develop some cross-ledges equally closely spaced. Nor would it seem that the appearance and increase in number of cross-ledges is a straightforward case of allometry for their number does not increase exponentially with increase in atrial size. Furthermore, if we turn to the species *L. fahrenheitzi*, *L. hippotragi* and *L. ovillus*, which were excepted from the *Linognathus* series tabulated above, the number of ledges present in their abdominal spiracles in relation to size agrees neither with those of other species of *Linognathus* nor with each other. Thus it may be concluded that the spacing of cross-ledges in the *Linognathus* spiracle is not fixed and that the ratio between number of ledges and atrial size is not necessarily the same in all species although it may be so in related species. It should be added that the lower limit of  $20\ \mu$  atrial diameter for the development of cross-ledges appears to apply equally to spiracles of both Siphunculata and Trichodectidae. In the Trichodectidae, although only a few species have been studied, those spiracles without cross-ledges, such as the abdominal spiracles of *Bovicola ovis*, *Cervicola longicornis* and *Eutrichophilus setosus*, are all about  $20\ \mu$  or a little less in diameter at the widest part of the atrium. The thoracic spiracle in each of these species is considerably larger and bears both annular and cross-ledges.

It has been suggested earlier that orthogenetic development in the Siphunculata is not confined to the spiracles. In sucking lice from the Ferungulata, for instance, there appears to be a tendency for the first pair of legs to become reduced and the second and third pairs enlarged. This has occurred independently certainly twice in the lice from *Pinnipedia* and in *Linognathus* and probably five or six times if other genera *Ratemia* and *Hybophthirus* are separately derived, as they almost certainly are, from lice with equal legs. Other characters acquired independently by more than one group are the fusion of the tibia and tarsus in some or all of the legs, the reduction of the thoracic notal and sternal plates, the disappearance of tergal, sternal and paratergal plates in the abdomen, the disappearance of the central portion of an entire genital plate in the male to form a lyriform plate and also the almost complete loss of eyes. It is not claimed that all these evolutionary trends have come about by orthogenesis although it is highly probable that this mode of development may be ascribed to some, but, whether this is so or not, it is quite evident that great care is needed in analysing the complex mixture of generalised and specialised characters to be found in all forms of lice existing today before an assessment of their affinities is made.

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## SECTION II

### HYDROGEN-ACTIVATING ENZYMES DURING THE INSECT METAMORPHOSIS

By Ivar Agrell

The problems concerning insect metamorphosis have been studied by different scientific methods. Investigations have been carried out within most insect groups as regards the morphological and histological changes characteristic of this developmental period, changes that often involve an extremely radical histolysis and histogenesis. These studies, however, give only scant information of the causes and mechanism of the metamorphic processes. Physiological, and particularly biochemical research on the metabolism during metamorphosis are necessary. The reports of this kind published to date are generally concerned with the integral metabolism, determined by means of the total amount of carbohydrate, fat, and protein, and they give only a limited insight into the nature of the metamorphosis. In order to understand the deeper causal relationships knowledge of the intermediate metabolism is essential. The insect material is usually too small to permit a micro-chemical determination of the different metabolites; the latter, moreover, are often instable, disappearing or changing during the course of the chemical analysis. The intermediate metabolism, however, may be studied to advantage through observations of the enzyme systems, for which the rule of small causes and great effects is valid. Even small amounts of animal substance can give results in enzyme experiments. Studies of the hormonal activity can also yield important results as regards the metamorphic process. Our knowledge of the hormonal mechanism is on the whole fairly limited and studies of this kind can give at present only causal results in connection with enzyme experiments.

The investigations reported here concern the intermediate oxidative metabolism. The fly *Calliphora erythrocephala* Meig., a highly specialized Dipter, which has been used as the experimental material of this study represents an advanced type of holometabolic metamorphosis.

As is well-known oxidation in the tissues takes place by means of the transport of hydrogen and electrons via enzyme systems with increasing redox potentials. Finally hydrogen is combined with the inhaled oxygen, resulting in the formation of water. The enzyme systems with higher redox potentials are in a sense unspecific. Hydrogen from many different primary hydrogen donors, the metabolites, pass through them. The oxidative enzyme systems with low redox potentials, the hydrogen-activating dehydrogenases, on the other hand, are specific in the sense that they usually act as hydrogen acceptors to only one hydrogen donor or to a certain group of donors. It is evident that a study of the latter enzyme systems should give a more distinct picture of the intermediate processes of oxidation. The activity of the dehydrogenase systems may be examined by means of the so-called *Thunberg* method. A certain amount of artificial hydrogen acceptor, a redox indicator—generally methylene blue—is permitted to oxidize the dehydrogenase system in question in an anaerobic environment. In this process the dye is reduced and decolorized and the rate of bleaching serves as a measure of the enzyme activity.



It is generally known that the total metabolism of the insect specimen, measured, for instance, as the intensity of respiration, passes a minimum during the metamorphosis. The reason for this phenomenon has been widely discussed. Some investigators have assumed a parallelism with the histolytical-histogenetical changes so that the magnitude of the metabolism would be proportional to the amount of organized substance. This may not be the case, however, for one reason, because the respiration continues to fall also after the histogenetical processes begin to predominate over the histolysis. It might be of interest here to consider the behaviour of the total dehydrogenase activity which can be measured in simple in vitro experiments where the pupal mass, influenced by the naturally occurring enzyme systems, acts as hydrogen donor to the methylene blue. It appears then that the spontaneous activity of this dehydrogenase system also passes a minimum. A comparison with the oxygen consumption in vivo shows essentially the same course, Fig. 1. The two test series were carried out at the same temperature,  $+25^{\circ}\text{C}$ , and were represented by the same individuals. It is correct, therefore, to assume the U-shape of the respiratory curve to be essentially due to a variation in the activity of the dehydrogenase systems. The curves are not identical, however. The deviation may be explained by the fact that the magnitude of the metabolism is determined to some extent also by oxidative enzyme systems with a higher redox potential.

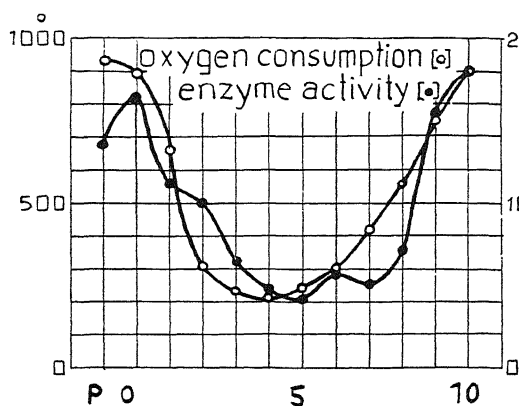


Fig. 1. Oxygen consumption and hydrogen-activating capacity, methylene blue reduction, during the metamorphosis of *Calliphora*. Activity expressed as  $100 \times$  inverse value of decolorization time. The ordinate represents ml O<sub>2</sub> per kg and hour respectively rate of methylene blue reduction. The abscissa represents pupal period in days. P denotes praepupa. After Agrell 1947. Acta Physiol. Scand. 1947. 14, 317.

The spontaneous decolorization of methylene blue can now be affected by the addition of various substances. Thus different organic compounds can act as hydrogen donors and possibly increase the methylene blue reduction, and certain substances may have an inhibitory effect on this respiration. By using substances of the first mentioned group one may learn qualitatively which enzyme systems are active. By adding substances with a more or less inhibitory effect on certain enzyme systems, these systems can be shut off and a quantitative determination of their activity can be obtained. In both cases a comparison is made with the unaffected methylene blue reduction and the positive or negative deviation from this rate after the addition of the respective substances is measured. A substance can increase the respiration as a hydrogen donor only where corresponding dehydrogenases are active and where the enzyme systems are not saturated with the donor in question. A change in this

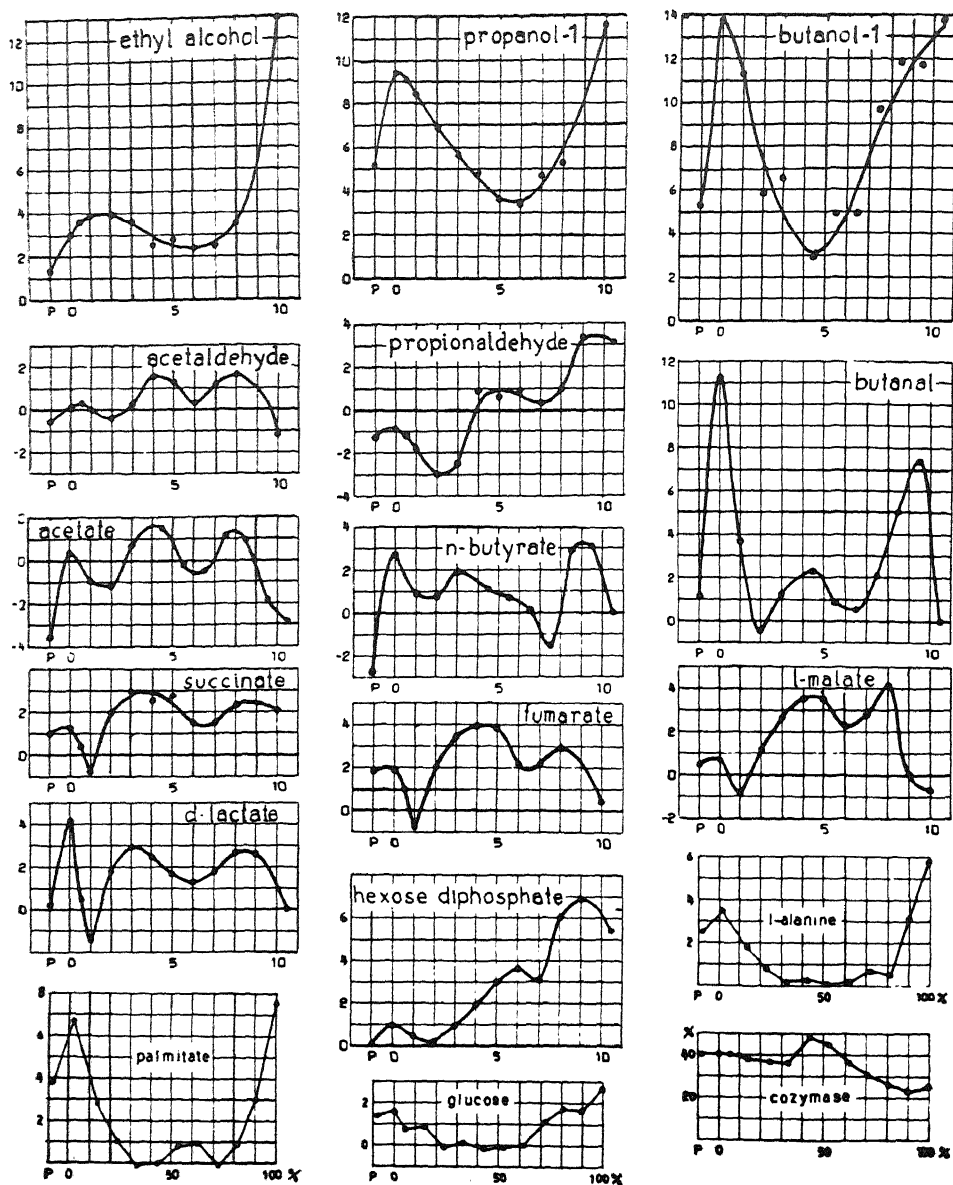


Fig. 2. The quantitative change in hydrogen-activating capacity after addition of various presumptive hydrogen donors during metamorphosis. The ordinate represents the change in activity expressed as difference between inverse value of decolorization time after donor addition and decolorization time in controls without addition of donors. The change after addition of cozymase is expressed in per cent. The abscissa represents pupal period in days or in per cent. P = praepupa.

metabolic rate reflects thus the concentration of naturally occurring donors, so-called spontaneous donors, in relation to the activity of the corresponding enzyme.

If various hydrogen donors are added and the quantitative change in the methylene blue reduction during the pupal development is followed, a distinct systematic fluctuation is observed, Fig. 2. On addition of, for example, aldehydes and certain organic acids periodically occurring maxima and minima are obtained, which appear with regular intervals and must be assumed to represent biochemically critical periods during the metamorphosis. The agreement in variation of activity, as will be elucidated further, may also indicate that the dehydrogenase systems in question are regulated by the same factors, possibly forming parts of the same oxidative cycle. The addition of other donor substances, however, produces a somewhat differently fluctuating change in the respiration, characterized by a more or less total disappearance of the maximum in the middle of the pupal period and a gradual increase in the respiration to hatching. This is particularly valid for the alcohols and also the  $\alpha$ -amino acids, dl- and l-, and the higher fatty acids.

In order to approach an explanation of the fluctuations observed both in the spontaneous methylene blue reduction and in the effect of various donor substances on this rate a more detailed investigation is necessary of the possible variation in activity of the different dehydrogenases during the metamorphosis, the apodehydrogenases. In these experiments the pupal mass is freed from low molecular and readily soluble donor substances and coenzymes by means of washing with distilled water followed by centrifugation. The protein portion of the dehydrogenases, the apoenzymes, are less soluble and can be assumed to remain in the tissues. The apoenzyme has in several cases shown itself to be strongly cell-bound. Such is also the case for certain necessary hydrogen mediators with higher redox potentials, for example diaphorase. In ordinary *Thunberg* experiments the various dehydrogenase systems may later be brought into action by the addition of different donor substances and coenzymes. In this way the variation in activity of a single apoenzyme or of the corresponding enzymatic chain or cycle can be followed.

Some dehydrogenases do not require any coenzyme for the transference of hydrogen. Among those is also the succinic dehydrogenase, which is believed to have a central position in the tissue oxidation. A determination of the activity of this enzyme during the metamorphosis shows a marked fluctuation, Fig. 3.

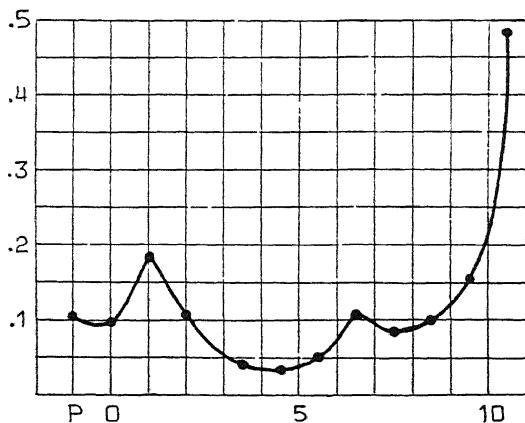


Fig. 3. Changes in the succinic-dehydrogenase activity under metamorphosis. The ordinate represents the degree of activity, the abscissa pupal period in days. After *Agrell* 1947. *Acta Physiol. Skand.* 1947. 14, 317.

It has been mentioned above that enzyme systems may be inhibited in their activity by certain substances. In this way the succinic dehydrogenase can be checked by malonate. Its actual activity can be studied through comparison with untreated controls. This malonate inhibition of the methylene blue reduction is represented in Fig. 4. The succinic dehydrogenase appears to be active mainly during the middle of the pupal period, i.e., during the period of minimal metabolism. The inhibition can then amount to more than 50 per cent. When the metabolism passes the minimum, thus about 50 per cent of the total capacity of methylene blue reduction is mediated by the succinic dehydrogenase. The great participation of this enzyme in the total respiration makes existence of a metabolic cycle probable, in which the succinic dehydrogenase system is included, according to, for instance, Krebs or Szent Györgyi. This assumption is further substantiated by the two following facts. The assumed succinic cycle is likely to affect other dehydrogenase systems as well. As has been pointed out a temporary increase of the methylene blue reduction can be observed on the addition of certain donors, occurring at the time of the malonate inhibition, Fig. 2. Further on, the addition of succinate to the unwashed pupal mass, which thus contains various spontaneous donors and coenzymes, and so other functional enzyme systems, an increase of the methylene blue reduction is obtained that can be up to 100 times greater, Fig. 2, than when these substances have been more or less completely washed away, Fig. 3. There is, therefore, reason to assume that when the respiration during the pupal development approaches a minimum it is supplemented by a previously inactive oxidative metabolic cycle, a succinic cycle, which prevents the respiration from falling too low.

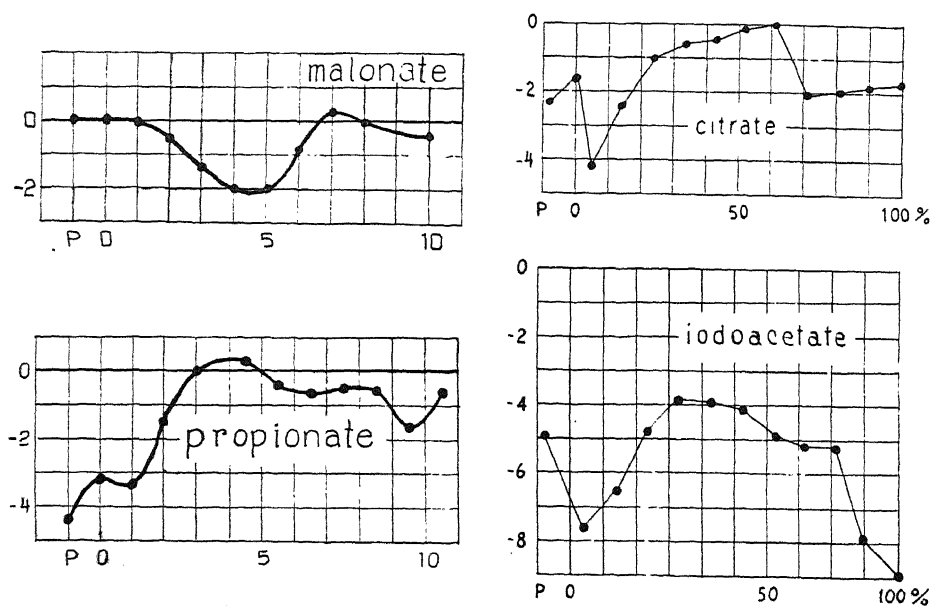


Fig. 4. The inhibiting effect of some substances, in conc. M/10, on the rate of methylene blue reduction during metamorphosis. The ordinate represents the degree of inhibition, the abscissa pupal period in days.

The succinic dehydrogenase needs no coenzyme to become active but the presence of both apo- and coenzyme is prerequisite for the activity of most other dehydrogenases. It is interesting, therefore, that the relative lack of codehydrogenase I, diphosphopyridine nucleotide, seems to be greatest when the metabolism is at minimum, that is to say, during the period when the succinic cycle is functioning, Fig. 2.

The codehydrogenase used is prepared in our own laboratory. The degree of purity is not yet established but is probably about 30 per cent. This preparation has been used to determine the variation in activity of some apodehydrogenases. The results appear in Fig. 5. Some important apodehydrogenases examined show a U-shaped

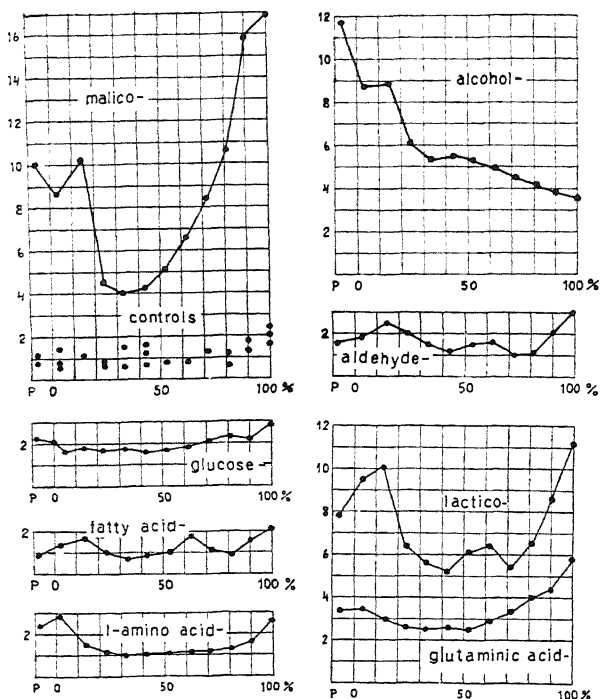


Fig. 5. Changes in activity of some apodehydrogenases during metamorphosis. The ordinate represents  $100 \times$  inverse values of decolorization time, the abscissa pupal period in per cent. The controls below the malicodehydrogenase curve concern all the diagrams and represent the addition of cozymase only. The donor substances added are respectively: l-malate propanol-1, d-glucose, butanal, d-lactate, palmitate, l-alanine and l-glutamic acid.

In conc. M/10.

variation in activity, malico-, lactico-, glutamic acid-, succinic-dehydrogenases and l-amino acid-oxidase, following the maximum at pupation similar to that of the total respiration. It appears likely, therefore, that the minimal metabolism during the metamorphosis primarily is caused by a diminished activity or concentration of the protein part of dehydrogenases, the apoenzyme, and not, or to a lesser extent, by a variation in donor or coenzyme concentration. It is possible that a decomposition takes place with a following resynthesis of the protein component. Some of the dehydrogenases examined have a deviating fluctuation in activity. Thus the activity of the apoenzyme of the alcohol dehydrogenase decreases with increasing age of development. The increase in the respiration towards the end of the pupal period on addition of alcohols to the unwashed pupal mass, Fig. 2, therefore can be due to a naturally occurring successive consumption of these hydrogen donors.

It appears from Fig. 5 that the activity of the various apodehydrogenases is quantitatively very different. The apoenzyme of the various dehydrogenases, however, is of different solubility, thus making it difficult to determine the absolute degree of their activity. It must be assumed that with the method used some part of the apodehydrogenase is washed away together with donors and coenzyme, and that this part varies in size for different enzymes. As regards the l-amino oxidases it must be added that the used dilution may be too strong. Possibly occurring fat-soluble enzymes should also disappear to some extent in the centrifugation. A gradation of the conditions of solubility of the various apodehydrogenases is so hardly possible to carry out also by means of the existing data in the literature. Judging from the experiments, Fig. 5, the activity of both the malico- and also the alcohol- and lactico-dehydrogenases, however, is remarkably high. Thus the former alone can give evidence of an activity not much below that characteristic of the respiration of the unwashed pupal mass.

It appears from this brief recapitulation of some experimental results that the greater part of the work still remains to be done in order to obtain a full comprehension of the oxidative metabolism during insect metamorphosis, although a somewhat diffuse picture of the main processes can be discerned. The method reported here, of charting the physiological phases by studying the enzymatic reactions, seems to offer a practicable way. The investigations are being continued.

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## REMARQUES SUR LES FACTEURS D'APPARITION DES AILÉS CHEZ LES APHIDIDAE

Par L. Bonnemaïson

La détermination des facteurs qui provoquent l'apparition des ailés chez les Aphididae présente un grand intérêt, tant du point de vue biologique que du point de vue économique.

Pour les espèces monoeciques, les pucerons ailés assurent simplement la dissémination de l'espèce sur des plantes identiques ou très voisines de celles sur lesquelles ils ont vécu.

Chez les espèces à migration absolue, les ailés apparaissent généralement au printemps ou au début de l'été; ils abandonnent l'hôte principal pour se porter sur l'hôte intermédiaire dans le courant de l'automne, les pucerons se trouvant sur ce dernier hôte produisent des mâles et des ailés (sexupares) qui vont déposer des femelles sexuées sur l'hôte principal.

Les pucerons sont de beaucoup les vecteurs les plus communs des maladies à virus des plantes et l'extension de ces affections est étroitement liée au nombre d'ailés existant dans les cultures ainsi qu'à la précocité de leur apparition.

Nos recherches ont porté principalement sur le Puceron cendré du Chou (*Brevicoryne brassicae* L.) et sur le puceron gris du Pêcher (*Myzus persicae* Sulz.).

En France, *B. brassicae* peut hiverner sous la forme de virginipare dans les régions méridionales ou à climat maritime ainsi qu'aux environs de Paris lorsque la température ne descend pas au dessous de  $-12^{\circ}$  à  $-15^{\circ}$ ; ces virginipares produisent des larves dès que la température moyenne est supérieure à  $+4^{\circ}$ ; dans ces conditions, les colonies se développent rapidement à partir de la fin février. Les oeufs d'hiver n'éclosent généralement que dans le courant du mois de mars; c'est pourquoi les pucerons cendrés du Chou sont beaucoup plus nombreux au printemps après un hiver doux qu'à la suite d'un hiver rigoureux qui n'a laissé subsister que les oeufs. Les virginipares aptères se tiennent à la face inférieure des feuilles des crucifères résistantes au froid (Chou, Colza d'hiver etc. . .) mais se portent de préférence sur les hampes florales; ils arrivent à constituer autour de celles-ci des gaines continues pouvant comprendre plusieurs milliers d'individus.

L'hiver 1944—45 a été rigoureux et a tué tous les virginipares aptères. Les premières colonies ne sont notées sur les hampes florales que le 23 mai 1945 et les ailés apparaissent le 5 Juin; le pourcentage d'ailés augmente rapidement par la suite et atteint 50,5 % le 21 Juin; tous les pucerons ont quitté les inflorescences avant la fin du mois. Sur les feuilles de Chou, le pourcentage le plus élevé a été de 87,5 % le 27 Juin (Fig. 1).

La douceur de l'hiver 1945—46 a permis à quelques virginipares aptères de persister pendant toute la mauvaise saison ce qui a donné lieu à un développement plus précoce des colonies. Les ailés apparaissent le 30 avril sur les hampes florales et le pourcentage maximum (90,6) est noté le 4 Juin; à la même date il est dénombré 83,6 % d'ailés sur les feuilles de Chou.

A l'automne, les colonies se multiplient à nouveau et il est compté 9,9 % d'ailés le 17 octobre, 29,2 le 24 octobre, 7,6 le 31 octobre, 10 le 8 novembre, 11,5 le 22 novembre, 2,5 le 28 novembre.

Les facteurs les plus variés ont été invoqués pour expliquer l'apparition des ailés : la nutrition déficiente (Keller 1887, Ewing 1916, 1925, 1926, Gregory 1917,

Wadley 1923, Ackermann 1926, Rivnay 1937) ou surabondante (Tannerreuther 1907, Borner 1914, Baker et Turner 1916), la dessiccation de la plante-hôte (Mordwilko 1907, 1908, 1909, Shinji 1918, Schaeffer 1938), la famine des larves ou des adultes (Gregory 1917, Wadley 1923, 1931, Ackermann 1926, Reinhard 1927), l'humidité de l'air et la teneur en eau des plantes (Rivnay 1937), la surpopulation (Davidson 1914, 1921, 1922, Ackermann 1926, Reinhard 1927), la température (Ewing 1916, 1925, 1926, Wadley 1923, Ackermann 1926, Shull 1929, 1935, L. M. Smith 1937), la lumière (Shull 1926, Wadley 1931, Evans 1938).

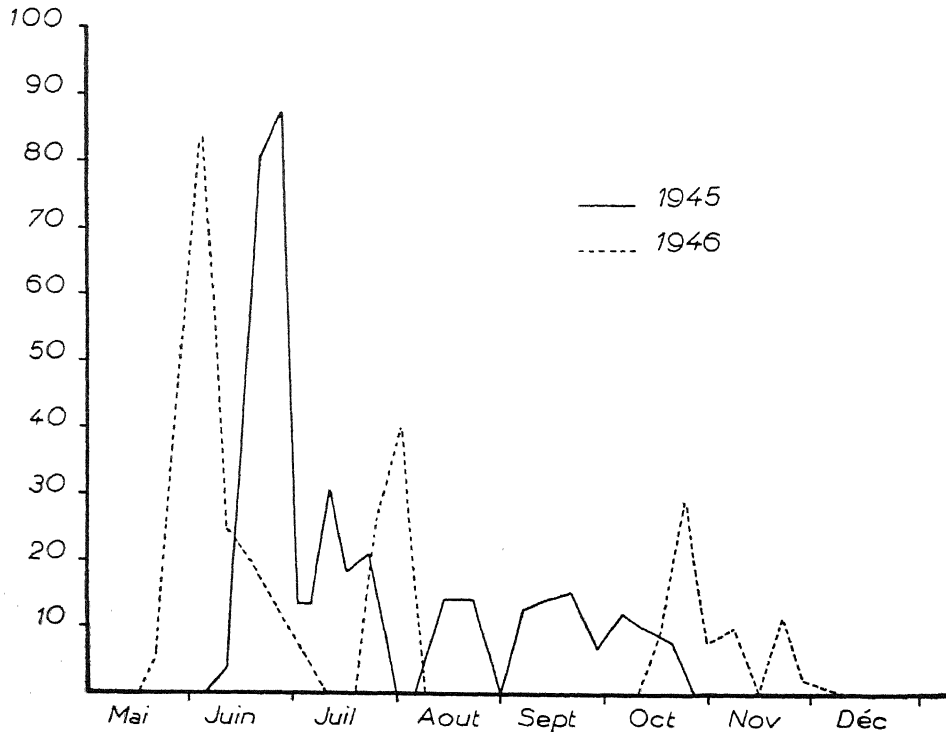
Enfin, quelques auteurs attribuent un rôle prépondérant à des facteurs internes, (Klodnitski 1912, Baker et Turner 1919, Davidson 1921, Mason 1922).

La quasi-totalité des chercheurs qui ont étudié l'action des facteurs abiotiques sur l'apparition des ailés ont opéré avec des plantes en pots ou plongeant dans des solutions nutritives. Les Aphides étaient déposés sur ces plantes qui étaient ensuite soumises à diverses conditions de milieu; température, humidité, lumière etc. . .

Cette technique présente le grave inconvénient d'indiquer l'influence de l'agent considéré sur le complexe plante-aphide et non sur l'animal lui-même.

Tous nos élevages ont été effectués sur des feuilles coupées de Chou; le pétiole plongeait dans l'eau et le limbe était mis dans une petite cage en matière plastique

% ailés





transparente. Dès que la feuille présentait les premiers symptômes de flétrissement, les pucerons étaient transférés sur une feuille fraîche; les insectes pouvaient être ainsi mis sans difficulté sous différentes conditions de milieu et la densité de la population pouvait être constamment contrôlée; la plupart des expériences ont été faites avec des élevages individuels.

Il ne peut être question de relater dans ce bref exposé, les résultats des expériences réalisées en vue de déterminer l'importance de chacun de ces facteurs; nous n'envisageons ici et très succinctement que trois d'entre eux : la température, la lumière et la surpopulation.

#### *Role de la temperature*

Ewing (1916) a obtenu 100 % d'aptères avec *Rhopalosiphum prunifoliae* F. à la température de 18° 3, et à des températures inférieures ou supérieures à 18°, une proportion d'ailés d'autant plus importante que la température est plus éloignée de 18° 3; il pense que la température optimum de développement des virginipares aptères est voisine, sinon identique, à celle amenant la production exclusive de formes aptères. D'après L. M. Smith (1937) il existe pour *Hyalopterus pruni* Koch une corrélation positive entre la température et le pourcentage d'ailés; Shull (1929), au contraire, opérant avec *Macrosiphum solanifolii* Ashm. conclut à une corrélation négative.

J'ai élevé *B. brassicae* à différentes températures constantes au printemps et à l'automne afin de voir, le cas échéant, si la saison n'exercerait pas une influence; ces observations ont été poursuivies pendant 2 à 5 générations consécutives; dans tous les cas il a été obtenu un pourcentage d'ailés nul ou insignifiant.

Shull (1935) a signalé que le transfert des larves à des températures différentes de celles auxquelles avaient été élevées les mères et les grand-mères amenait une augmentation du pourcentage d'ailés; nous avons élevé à 18°, des larves dont les mères avaient effectué tout leur développement à 24° ou 12°; d'autres lots de larves produites par des mères dont toute la croissance avait eu lieu aux températures constantes de 8° et 18° ont été mis dans des étuves à 24°. Ces changements de températures n'ont pas favorisé la production des ailés (1,9 % en moyenne).

Des expériences analogues ont été faites avec *M. persicae* et ont abouti aux mêmes résultats.

#### *Role de la lumière*

D'après Shull (1927, 1928, 1929, 1932, 1935), la lumière exerce une grande influence sur l'apparition des ailés chez *Macrosiphum solanifolii* Ashm. élevé sur des pommes de terre en pots; ces plantes recevaient uniquement l'éclairage fourni par une lampe électrique ordinaire d'une puissance de 100 watts. Il a été obtenu près de 100 % d'ailés avec un éclairage d'une durée de 2 à 12 h. par jour et un pourcentage voisin de 0 % avec un éclairage journalier de 14 à 24 h. par jour.

Nous avons procédé à des élevages individuels de *B. brassicae* sur feuilles coupées et à la température du laboratoire (moy. 18°—20°); la souche était constituée par un virginipare aptère récolté dans une serre froide au printemps de l'année 1945; durant trois années (75 générations), il fut obtenu presque exclusivement des aptères (pourcentage maximum d'ailés : 5,88).

Nous avons également élevé *B. brassicae* pendant plusieurs générations consécutives sous différentes conditions d'éclairage : lumière permanente (lumière naturelle complétée par une lumière artificielle), lumière naturelle, lumière naturelle réduite à une

durée de 7 h. 30 par jour, obscurité continue; dans tous les cas, le pourcentage d'ailés fut nul ou inférieur à 3 %. Ces expériences ont été faites au printemps, en été en automne et en hiver afin de rechercher si la saison n'exerçait par une influence.

Des résultats similaires ont été obtenus avec *M. persicae* lorsque les expériences ont été faites au printemps et pendant l'été; à l'automne, il apparaît un petit nombre d'ailés en mélange avec les sexupares (Bonne-maison 1948).

### *Role de la surpopulation*

Toutes les expériences citées précédemment ont été obtenues par des élevages individuels où des précautions particulières étaient prises afin d'éviter une trop grande densité des insectes sur les feuilles.

*B. brassicae* présente une tendance assez accusée à vivre en colonies compactes formées par la réunion des larves autour de leur mère; le même fait s'observe avec *Aphis fabae* F., *Sappaphis plantaginea* Pass., etc. . . Par contre, d'autres espèces, telles que *M. persicae* Sulz, *Macrosiphum euphorbiae* Thom., se dispersent sur le feuillage ou la portion du végétal qui leur est offerte. Il arrive cependant que la recherche de tissus leur convenant bien, les amène à se grouper; ceci se produit principalement lorsque la plante-hôte commence à se dessécher; les pucerons migrent alors peu à peu vers les feuilles encore vertes. L'aboutissement est une "surpopulation" qui résulte dans le premier cas d'un instinct grégaire et qui n'est dans le second qu'une conséquence indirecte d'une raréfaction de l'aliment.

Cette concentration d'un grand nombre d'individus se traduit évidemment, en raison du grand nombre de piqures nutritives effectuées sur une faible surface, par une réduction quantitative et qualitative de la nourriture; mais il intervient également un autre facteur, "l'effet de groupe" dont l'influence a été récemment démontrée chez les insectes (Grassé 1942).

Le groupement artificiel des aphides sur une petite surface foliaire est facilement obtenu par l'emploi de "cellules", ou plus simplement encore par le dépôt d'un grand nombre de pucerons sur une faible surface foliaire.

Les aptères qui restent sensiblement immobiles pendant toute la période de reproduction et dont les descendants se développent en contact étroit avec eux engendrent un pourcentage élevé d'ailés; par contre, les larves mises en surpopulation pendant toute l'existence larvaire ne se transforment pas en ailés et n'engendrent pas d'ailés.

Ces faits permettent d'expliquer les observations faites en plein air et signalées au début de cet exposé. Au printemps, les colonies se multiplient rapidement et se concentrent sur les hampes florales, de préférence aux feuilles; cette surpopulation, complétée par l'épuisement des cellules et la dessiccation physiologique amène la production d'une proportion importante d'ailés; le même phénomène quoique moins marqué, a lieu à l'automne.

On peut se demander pourquoi, les ailés sont relativement rares pendant l'été; la cause essentielle réside en l'action des prédateurs (Syrphidae, Coccinellidae) et parasites (Braconidae, Chalcididae etc. . . qui déciment les colonies et ne permettent plus à "l'effet de groupe" d'exercer ses effets.

Il s'établit donc dans la nature des relations complexes, mais étroites, entre les facteurs abiotiques, qui agissent sur l'équilibre biologique existant entre les pucerons et leurs ennemis ainsi que sur l'état physiologique de la plante, la production des formes ailées, et en conséquence sur la dissémination des espèces.

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## OBSERVATIONS ON TROPICAL WASPS IN TRINIDAD

By Edward Callan

The observations described relate to Trinidad, British West Indies, an island some 1,750 square miles in area, lying in close proximity to Venezuela opposite the delta of the River Orinoco. The northern part of the island is mountainous, attaining an elevation of 3,085 feet, and other ranges of lower hills occur in the centre and south of the island. There are also several small savannas and two large swamps. Much of the island is covered with forest, but other areas are given over to agriculture, especially the cultivation of sugar cane, cacao, citrus and coconuts. The climate is tropical and there are well marked dry and rainy seasons. Trinidad is ecologically a part of South America, from which it became separated in comparatively recent times, and its fauna and flora have close affinities with those of the adjacent part of the continent and not with the Antilles.

The aculeate superfamilies Vespoidea and Sphecoidea are well represented in Trinidad for an island of its size. Among the Vespoidea most attention has been given to the Vespidae, but preliminary observations have been made on the Mutillidae, Scoliidae, Chrysididae and Pompilidae. Although the Bethyridae and Dryinidae occur, they have been studied scarcely at all.

The solitary Vespidae comprise several genera, such as *Eumenes*, *Odynerus*, *Monobia* and *Zethus*, which exhibit different methods of nest construction. The commonest species is the potter wasp, *Eumenes canaliculatus* (Olivier), which constructs globular mud nests and provisions them with lepidopterous larvae. This species appears to be becoming domestic in habit, as it often builds its nests in houses. Parasitism by Chrysididae, Chalcididae and Rhipiphoridae is not uncommon.

The social Vespidae are represented by some 25 species, *Polistes*, *Polybia* and *Mischocyttarus* being important genera. The Polybiinae are the dominant subfamily and include many distinct structural species with numerous colour forms or subspecies. Some live in large colonies and regular swarming takes place from time to time. The prey, which consists of lepidopterous larvae and other insects, is pre-masticated before being fed to the wasp larvae. One species, *Polybia occidentalis* (Olivier), has been observed preying on a wide range of insects, including winged termites and gall midges. *Synoeca surinama* (Linnaeus) has been observed attacking worker honey-bees at the entrance to the hive. Several different species exhibit remarkably similar coloration, some with docile habits being so similarly coloured to wasps of other genera with aggressive habits that it is difficult to tell them apart. Various other Hymenoptera and a few Coleoptera, Diptera and Lepidoptera show striking colour-pattern resemblance to some social wasps. *Apoica pallida* (Olivier) is a true nocturnal wasp. It has greatly enlarged ocelli and is frequently attracted to artificial lights. *Polistes canadensis* (Linnaeus) is the most familiar wasp associated with settled areas and is found nesting almost invariably in close proximity to houses. Parasites include Strepsiptera, Chalcididae and Ichneumonidae, and the larvae of various Lepidoptera and Diptera live as scavengers or inquilines in the nests.

The Mutillidae comprise several genera about which comparatively little is known. *Timulla eriphyla* Mickel is known to be parasitic on Larridae and *Hoplomutilla opima* Mickel to parasitize Anthophoridae, while others are thought to attack the Bembicidae.

The Scoliidae are represented by a number of genera, but, apart from the fact that they are ectoparasites of various Scarabaeidae, very little is known of their habits. The Chrysidae are poorly represented, the most familiar species being parasites of solitary Vespidae. The Pompilidae are well represented and comprise a number of genera. Spiders are preyed upon exclusively, and a large species of *Pepsis* provisions its nest with the huge so-called tarantula spiders of the American tropics. Almost all the Pompilidae are fossorial in habit, but a species of *Pseudagenia*, which is not uncommon in houses, constructs mud nests attached to walls and other places and stores them with spiders. The Bethyridae and Dryinidae have been very little studied. *Proethylus callani* Richards has been recorded as a parasite of Embioptera, and *Mesodryinus poecilopterae* Richards is known to parasitize Flatidae.

Among the Sphecoidea scarcely any work has been done except on the Bembicidae and Trypoxylonidae, although a few observations have been made on the Sphecidae, Larridae, Ampulicidae, Stizidae, Nyssonidae, Philanthidae, Pemphredonidae, Crabronidae and Oxybelidae. The Bembicidae comprise the genera *Rubrica*, *Stictia*, *Bicyrtes* and *Microbembex*. They are fossorial wasps with rather varied preying habits, some species provisioning their nests with Diptera, while others prey upon the nymphs of Coreidae, Pentatomidae and other families of Heteroptera. The preying habits of *Rubrica surinamensis* (De Geer) have been studied in some detail. Nesting sites occupy bare areas of hard ground fully exposed to the sun. The wasps live in semi-social communities, each with a separate nest, the entrance to the burrow being closed and carefully concealed when the nest is left unattended. Progressive provisioning is practised and the prey, which consists entirely of Diptera, is stung to death by the wasp. Large or medium-sized flies of many families are chosen, especially the Tabanidae, Syrphidae and Stratiomyidae. House-flies and stable-flies are sometimes preyed upon. Occasionally insects other than Diptera are captured by mistake and there are records of Odonata and Lepidoptera being taken as prey.

The Trypoxylonidae are represented by some 20 species. Their nests are stored exclusively with spiders. The majority of species build mud nests, but others utilize holes of a convenient size or the old nests of mud-dauber and potter wasps. The largest species, *Trypoxylon palliditarse* (Saussure), constructs striking cylindrical mud nests not infrequently on the walls of buildings. *Trypoxylon nitidum* (Smith) is the commonest species in houses. It is a key-hole wasp and, instead of building a nest, stores its spider prey in key-holes, nail-holes, book-backs and other suitable openings, which are plugged with mud.

The Sphecidae include the genera *Sphex*, *Ammobia*, *Priononyx*, *Isodontia* and *Sceliphron* preying on lepidopterous larvae, Orthoptera and spiders. The most familiar species are *Ammobia ichneumonea* (Linnaeus), which stores its nests with long-horned grasshoppers, and the mud-dauber wasp, *Sceliphron fistulare* (Dahlbom), which builds its mud nests commonly in houses and provisions them with spiders. The Larridae comprise several genera, such as *Larra*, *Notogonidea*, *Tachytes* and *Tachysphex*, which prey on Orthoptera. *Tachysphex blatticidus* Williams attacks cockroaches, while several species of *Larra* prey on mole-crickets. *Larra americana* (Saussure), which occurs in Trinidad, has been successfully established in Puerto Rico for the control of the West Indian mole-cricket, *Scapteriscus vicinus* Scudder. Little is known of the Ampulicidae, but they probably prey on cockroaches as in other parts of the world. The Stizidae are represented by a single species, *Bembecinus cingulatus* (Smith), which burrows in the ground and lives in semi-social communities like the Bembicidae. The nests are

progressively provisioned with the nymphs and adults of Jassidae. The Nyssonidae have been little studied, but at least one species, *Hoplisoides umbonida* Pate, is known to prey upon Membracidae. The Philanthidae include *Philanthus* and *Cerceris* and have very varied preying habits, different species being known to utilize Andrenidae, Meliponidae, Chrysomelidae, Curculionidae and Buprestidae as prey. The prey of one species observed storing its nest with Buprestidae was found entirely to comprise undescribed species of this family of beetles. Other species of wasps are not infrequently observed with undescribed prey. An explanation of this might be that the insects taken as prey normally inhabit the forest canopy, where they have remained uncollected and unknown until captured by the wasps. A single species of the Pemphredonidae is known and this preys upon Aphididae. The Crabronidae are poorly represented, but include the genera *Crossocerus* and *Microstigmus*, the latter being known to provision its nests with Collembola. The Oxybelidae occur and probably prey on Diptera.

It is a remarkable fact that certain species of Vespidae, Pompilidae, Trypoxylonidae and Sphecidae appear to nest almost invariably either in close proximity to houses or actually within them. It appears that these wasps are becoming domestic species. Some of them seem to be associated with man's dwellings in much the same way as birds such as swallows and housemartins. While this habit of nesting in houses can be explained in part no doubt in Pompilidae, Trypoxylonidae and Sphecidae by their propensity for preying on spiders, this explanation cannot be extended to the domestic Vespidae which prey on lepidopterous larvae.

In other tropical countries far more detailed observations have been made on aculeate wasps. This account of observations in Trinidad indicates how rudimentary is our knowledge of their habits in this part of the tropics and emphasises the need for further study.

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## LES FOSSETTES TÉGUMENTAIRES ABDOMINALES DES NABIDÉS (Hemipt. Heter.)

Par Jacques Carayon

Aucun des travaux, consacrés jusqu'ici à la morphologie ou à la systématique des Nabidés, n'a mentionné, semble-t-il, les organes tégumentaires qui existent sur l'abdomen chez de nombreux représentants de cette famille.<sup>1</sup>

Ces organes sont essentiellement constitués par des groupes particuliers de soies, insérées sur des zones tégumentaires plus ou moins différenciées et généralement déprimées en fossettes; ils sont pairs et toujours situés à proximité des stigmates. Je les désignerai, provisoirement du moins, sous le nom de "fossettes parastigmatiques". Leur signification physiologique m'est encore inconnue, et mon propos, dans cette note, est surtout de décrire leur conformation et les variations qu'elles présentent parmi les Nabidés.

D'après la disposition et la forme, on peut distinguer deux types principaux d'organes parastigmatiques: l'un se rencontre dans la sous-famille des Nabinés; l'autre dans celle des Prostemminés. D'après ce que j'ai observé chez des Hémiptères appartenant aux genres *Scotomedes* et *Gorpiis*, les *Scotomedinés* et les *Gorpinés* paraissent dépourvus de tels organes.<sup>2</sup>

### NABINAE

Si l'on examine, à un grossissement suffisant, la face ventrale de l'abdomen, chez des imagos appartenant à des espèces du genre *Nabis* (sous-genre *Nabis*), telles que *N. ferus* (Lin.), *N. rugosus* (Lin.), *N. capsiformis* Germar, *N. roseipennis* Reut., on constate qu'il existe une fossette tégumentaire sur la marge interne du connexivum, à côté de chacun des deux stigmates du septième urite. Chez ces espèces de *Nabis*, la partie ventrale du connexivum est fortement gonflée en un bourrelet, dont la zone interne vient normalement s'appliquer contre la paroi latérale de l'abdomen. Les fossettes parastigmatiques se trouvent d'ordinaire plus ou moins dissimulées dans le sillon ainsi formé; elles ne deviennent bien visibles que chez les individus à abdomen particulièrement distendu (femelles gravides par exemple).

Le plus souvent ces organes sont difficiles à voir sur des exemplaires desséchés; dissections ou traitements par la potasse sont nécessaires pour une étude précise de leur conformation.

Après un tel traitement, chaque fossette apparaît comme une cavité à peu près hémisphérique, dont l'orifice, circulaire ou légèrement ovale, s'ouvre en arrière des stigmates de l'urite 7, sur le latérotergite ventral et près de la suture entre ce dernier et le sternite correspondant (fig. 1). Les parois de cette cavité sont plus fortement infléchies, par rapport à la surface, du côté antérieur et interne que du côté opposé; elles portent des poils, qui ne paraissent différer de ceux normalement dispersés sur les

<sup>1</sup>H. M. Harris (Entomologica Americana, IX, 1928, n° 1 & 2, p. 13) a signalé ces formations tégumentaires chez les *Alloeorhynchus*, mais en les confondant avec des stigmates du premier segment abdominal.

<sup>2</sup>Il reste à examiner à cet égard *Arachnocorinae* et *Carthasinae* représentés par des espèces en général peu nombreuses et rares, dont il m'a été impossible d'obtenir jusqu'ici des spécimens étudiables en détail.

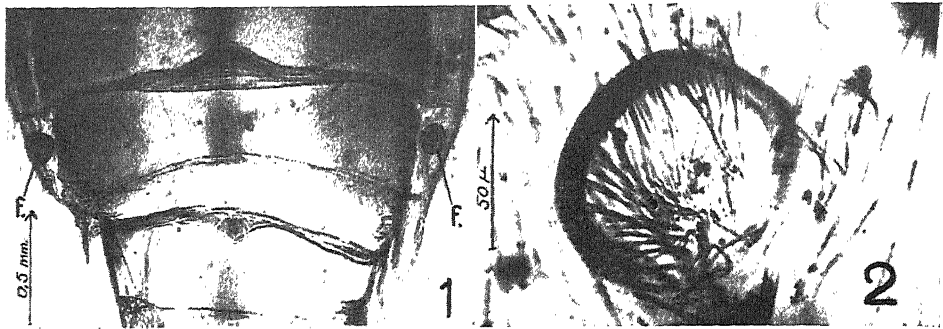


Fig. 1. Région postérieure et ventrale de l'abdomen chez un mâle de *Nabis rugosus* f., fossette parastigmatique.

Fig. 2. Même individu. Fossette de l'urite 7.

Photomicrographies de préparations à la potasse. La flèche est dirigée vers la tête de l'insecte; sa longueur indique l'échelle.

téguments que par leur groupement particulier; partant de nombreux points de la cavité, ils se dirigent vers l'arrière tout en convergeant les uns vers les autres de telle façon que leurs portions apicales entrent en contact (fig. 2 et 3). Les poils de la région antérieure de la cavité sont plus longs que ceux de la région postérieure; dans leur ensemble, ils forment une sorte de pinceau dont l'extrémité dépasse à peine l'orifice de la fossette.



Fig. 3. Fossette parastigmatique de l'urite 7 chez *Nabis ferus*; vue latérale; préparation à la potasse. st., stigmatum.

Fig. 4. Fossette parastigmatique dans une coupe transversale de l'abdomen chez la même espèce. Hémalun-éosine, f., fossette; oe., oenocytes; tr., tronc trachéen stigmatique.

Sur coupes histologiques (fig. 4), les soies apparaissent aussi nettement convergentes; elles se montrent de plus comme plongées en grande partie dans une sécrétion qui, mêlée à des débris d'origine extérieure, forme une masse occupant presque toute la cavité, mais en laissant libre la base des soies<sup>3</sup>. Après l'emploi de fixateurs osmiés, suivi d'un traitement au pyrogallol, la sécrétion est densément noire; sur l'insecte entier, les fossettes abdominales se détachent alors nettement sur le fond clair des téguments

<sup>3</sup> Une rétraction due aux agents fixateurs est peut-être responsable de cette absence constante de sécrétion à la base des soies.



par l'imprégnation en noir de leur contenu. Cette sécrétion semble invisible chez l'insecte vivant; en dehors des faibles indications que donnent ses caractères d'imprégnation et sa persistance après l'action des réactifs histologiques, rien ne permet encore de connaître sa nature chimique.

La cuticule des fossettes parastigmatiques apparaît, sur préparations à la potasse, plus foncée en général que celle des régions voisines; elle est percée de pores et présente une microsculpture granuleuse; les coupes montrent l'existence à ce niveau d'une exocuticule brune, qui est absente ou très réduite dans la zone peu sclérifiée entourant chaque fossette. Les poils convergents qui occupent celles-ci paraissent être des soies sensorielles de type "articulé"; chacun est inséré dans une cavité de l'exocuticule et se trouve relié à l'hypoderme par un fin canal. La structure histologique de cet hypoderme n'est pas, ou fort peu, modifiée, au niveau des fossettes parastigmatiques, chez les insectes adultes du moins; les cellules en sont à peine plus hautes et plus serrées que celles de l'hypoderme du tégument normal. Les méthodes histologiques courantes, que j'ai seulement utilisées jusqu'ici, ne m'ont pas permis d'y distinguer des cellules sensorielles ou des terminaisons nerveuses. Je n'ai pas trouvé non plus, chez les imagos, ni dans l'hypoderme ni à proximité, des cellules glandulaires pouvant être considérées comme responsables de la sécrétion emplissant les fossettes.

Ces dernières n'existent telles qu'elles viennent d'être décrites que chez les imagos, où elles sont semblables dans les deux sexes. Chez les larves des mêmes espèces, il y a des formations tégumentaires comparables à celles des imagos, et situées de la même façon par rapport aux stigmates, mais sur les quatrième, cinquième et sixième urites; elles sont peu différenciées et constituées par des groupes d'une dizaine de poils convergents, insérés sur des plages ovales à peine déprimées, qui diffèrent légèrement par leur coloration et par leur microsculpture du tégument voisin. Ces plages sont longues de 70 à 80  $\mu$  au cinquième stade larvaire de *N. rugosus*. Une tâche noire apparaît au niveau de chacune d'elle, après l'action successive d'un mélange osmique et d'une solution de pyrogallol; elle indique la présence probable d'une sécrétion analogue à celle de la fossette des imagos. Chez ces derniers les plages parastigmatiques des urites 4 à 6 persistent, mais sont d'ordinaire réduites à l'état de vestiges, du moins chez les espèces du sous-genre *Nabis*.

Bien que correspondant toujours à un même type général, la disposition et la conformation des fossettes parastigmatiques présentent, dans le groupe des Nabinés, des différences sensibles d'un genre à un autre, ou même entre sous-genres distincts.

Chez les imagos du *S. G. Himacerus* [*H. apterus* (Fabr.), *H. myrmecoides* (Costa), *major* (Costa)], il existe non plus une seule mais quatre paires de fossettes parastigmatiques; elles sont situées sur les urites 4 à 7, et dans une région correspondant aux latérotergites ventraux, qui sont ici fusionnés avec les sternites.

Les fossettes sont formées par d'assez grandes plages ovales et légèrement déprimées de cuticule sombre (fig. 5); elles portent des poils dirigés vers l'arrière et plus ou moins convergents. Ces fossettes sont d'autant plus importantes, d'autant mieux individualisées par rapport au tégument voisin, qu'elles sont plus postérieures; celles du septième urite, plus grandes et plus profondes, ont un contour cordiforme et sont très sensiblement plus différenciées que les autres; elles n'apparaissent d'ailleurs que chez les imagos, tandis que les fossettes des urites 4, 5 et 6 existent déjà chez les larves, avec une forme et des dimensions, qui — au stade 5 du moins — sont très voisines de celles de l'imago. Mais chaque fossette larvaire ne présente qu'une vingtaine de soies (fig. 6),

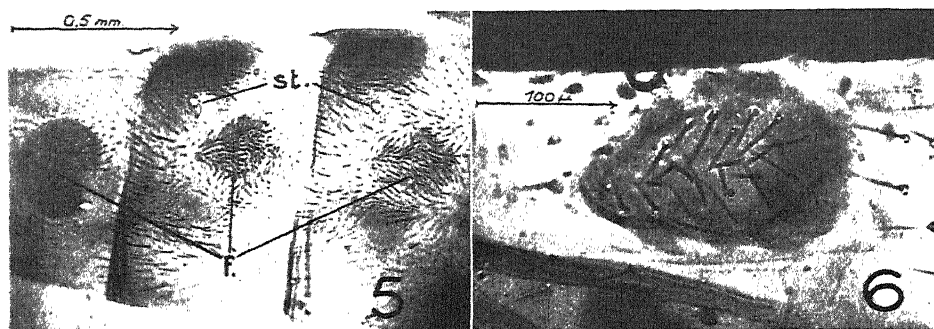


Fig. 5. Fossettes des urites 5 à 7 chez un imago d'*Himacerus lativentris*.  
 Fig. 6. Fossette d'une larve au stade 5 de la même espèce. Préparations à la potasse.  
 Mêmes lettres et indications qu'aux fig. précédentes.

tandis que celles des imagos possèdent des soies beaucoup plus nombreuses et plus denses.

Les *Hoplistoscelis* (*sordidus* Reut.) présentent une disposition intermédiaire entre celle des *Nabis* et celle des *Himacerus* : leurs fossettes parastigmatiques imaginaires, au nombre de 4 paires, comme chez *Himacerus*, sont surtout différenciées sur le septième urite, où elles affectent la forme en cupule hémisphérique propre aux *Nabis*.

Chez *Halonabis sareptanus* Reut., proche de ces derniers, les soies de la dernière paire d'organes parastigmatiques sont groupées en brosses, sans que la zone tégumentaire où elles sont insérées soit déprimée en cupule.

C'est une disposition de type larvaire, qui persiste chez les imagos de *Dolichonabis*, où les organes parastigmatiques sont identiques à ceux des larves, et situés comme chez elles sur les urites 4 à 6.

Le sous-genre *Nabicula* (*N. subcoleoptrata* Kirby) diffère sensiblement des autres en ce que les groupes de soies convergentes, voisins des stigmates, sont au nombre de 5 paires, et sont insérés sur des zones tégumentaires peu différenciées.

Les fossettes parastigmatiques de *Nabis flavomarginatus* Scholtz sont au nombre de 4 paires de dimensions presque identiques; elles rappellent les fossettes larvaires des *Himacerus*; ce *Nabis* s'écarte par là de toutes les autres espèces du sous-genre *Nabis*, que j'ai pu examiner, et mériterait sans doute d'être rangé dans un sous-genre distinct.

Enfin, chez les imagos du genre *Arbela*, dont j'ai examiné des spécimens de l'espèce *A. elegantula* Stål, il existe 3 paires de fossettes parastigmatiques identiques; elles ont la forme de cupules hémisphériques, analogues à celles du septième urite des *Nabis*, mais beaucoup plus petites; leur diamètre est de peu supérieur à celui des stigmates voisins, et elles sont pourvues de quelques soies courtes difficiles à voir.

La diversité rencontrée dans la conformation et la disposition des organes parastigmatiques des *Nabinae* fournit d'utiles indications en systématique, et permettra sans doute de préciser les affinités ou les différences entre les genres et sous-genres de ce groupe. Elle offre de plus l'intérêt de montrer les états intermédiaires entre le tégument normal et les fossettes parastigmatiques bien différenciées, telles que celles du septième urite des *Nabis*.

## PROSTEMMINAE

L'appareil parastigmatique abdominal, qui existe chez la plupart des *Prostemminae*, ne comporte qu'une paire d'organes; ceux-ci sont formés par des groupes de soies, généralement insérées sur des dépressions tégumentaires, comme chez les *Nabinae*; mais ils diffèrent surtout des organes de ces derniers par leur position dans la région antérieure de l'abdomen, sur la partie ventrale du troisième urite.

Seuls, parmi les *Prostemminae*, les *Phorticus* paraissent totalement dépourvus de tels organes, et il en est de même pour le genre monospécifique très voisin *Aristonabis* (*A. pulcher* Reut. et Popp.).

Les *Prostemminae* du genre *Pagasa* — d'après ce que j'ai observé chez *P. aenescens* Stål — n'ont, même au stade imaginal, que des formations parastigmatiques peu différenciées; ce sont des groupes de soies convergentes insérées sur des plages ovales et plus foncées que les téguments voisins; ces plages sont symétriquement situées sur le troisième urite en avant des stigmates, et sont contiguës au bord postérieur du deuxième urite; elles ressemblent à celles qui existent — comme nous le verrons plus loin — chez les larves des *Alleorhynchus*.

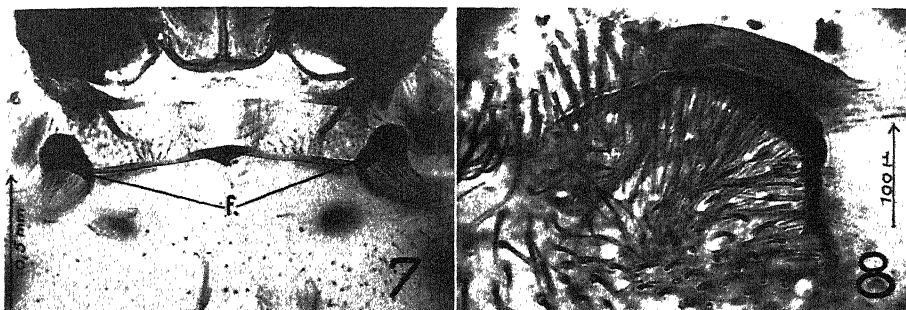


Fig. 7. Région antérieure et ventrale de l'abdomen chez une femelle d'*Alleorhynchus elegans*. f., fossettes.

Fig. 8. Fossette d'une femelle de *Prostemma guttula*.  
Préparations à la potasse.

Chez les imagos des *Prostemma*, les fossettes parastigmatiques sont nettement plus différenciées; elles sont constituées par une paire de dépressions tégumentaires bien marquées, qui sont situées au bord antérieur du troisième urite, et repoussent devant elles le bord postérieur de l'urite précédent; ces dépressions sont largement ouvertes et orientées obliquement de façon telle que leur concavité regarde en arrière et en dehors; elles sont hérissées de poils convergents dont l'ensemble s'oriente dans cette même direction, et dépasse peu l'orifice des fossettes (fig. 8).

Les larves des *Prostemma*, autant que je puisse en juger par l'examen de celles de *P. guttula* (Fabr.), ne présentent aucune formation tégumentaire comparable à celles des imagos.

C'est dans le genre *Alleorhynchus*, que les organes parastigmatiques atteignent leur maximum de différenciation; ils sont situés comme chez les *Prostemma*, mais sont formés par des dépressions tégumentaires plus étroites, et qui s'enfoncent si profondément vers l'avant dans le deuxième urite qu'elles semblent, au premier abord, appartenir à ce segment.

Les fossettes des *Alleorhynchus* ont une forme en cloche dissymétrique, dont l'orifice est orienté obliquement, comme chez les *Prostemma*, vers l'arrière et l'extérieur (fig. 7); elles sont pourvues de poils nombreux et particulièrement longs qui forment une touffe dense dépassant beaucoup leurs orifices.

Aux stades larvaires, les *Alleorhynchus* n'ont pas des fossettes tégumentaires de ce type, mais présentent au voisinage des stigmates du troisième urite une paire d'organes chacun formé par un groupe de poils insérés dans le fond d'une légère dépression en gouttière des téguments.

De même que chez les *Nabinae*, les poils des fossettes parastigmatiques des *Prostemmae* sont en grande partie plongés dans une sécrétion, qui apparaît sur les coupes histologiques comme un coagulum plus ou moins lacuneux et assez fortement colorable par l'éosine. Cette sécrétion paraît particulièrement abondante chez les *Alleorhynchus*, dont les spécimens conservés dans l'alcool présentent souvent leurs fossettes abdominales remplies d'une masse blanche de sécrétion coagulée. Chez les insectes adultes, l'hypoderme, au niveau des fossettes, ne montre aucune particularité pouvant expliquer la production de cette substance. Par contre, chez les larves proches de la mue imaginale, ou chez les imagos venant de muer, les cellules du tégument formant les fossettes sont nettement plus hautes, plus riches en vacuoles que celles des régions voisines. Plus frappantes sont l'abondance et la taille particulièrement grandes des oenocytes, qui sont groupés, à cette période, contre l'hypoderme des fossettes; leurs dimensions sont, en moyenne, supérieures d'un tiers à celles qu'ils présentent, au même moment, dans d'autres régions du corps; leur cytoplasme est fortement vésiculeux; leur noyau, gros et riche en grains de chromatine, apparaît avec un contour polygonal.

D'après ce que j'ai observé chez *Prostemma guttula*, ces volumineux oenocytes persistent encore autour des fossettes abdominales pendant un certain temps après la mue imaginale; et ils ne persistent que là. Mais, plus tard, les oenocytes, que l'on trouve au voisinage de ces organes, ne sont ni plus abondants, ni plus développés qu'en d'autres régions des téguments.

Ces constatations permettent de penser que la sécrétion se produit seulement pendant une période limitée au voisinage de la mue, et que les oenocytes interviennent, au moins indirectement, dans cette sécrétion. Il ne s'agit là que d'une hypothèse, qui ne pourra être vérifiée que par des observations histologiques et cytologiques ultérieures.

\* \* \*

Les fossettes parastigmatiques des Nabidés sont, à certains égards, comparables avec des organes tégumentaires, déjà connus dans d'autres groupes. Beaucoup d'organes sensoriels ont été décrits, qui sont ainsi formés par des cavités tégumentaires, où sont insérées des soies sensorielles. Le plus souvent cependant ces dernières ont une structure particulière, et se trouvent en relation avec des groupes de cellules bien différenciées de l'hypoderme (sensilla de type chimio-récepteur par exemple). Ce n'est pas le cas des fossettes des Nabidés, dont les soies sont du type tactile et ne diffèrent pas sensiblement de celles du tégument voisin.

Il y a déjà plus de points communs entre les fossettes des Nabidés et les organes tégumentaires abdominaux récemment signalés chez un Mallophage par Th. Clay; ceux-ci sont formés par deux groupes de soies peu modifiées, symétriquement situés dans deux échancrures du bord postérieur du sixième tergite, et dont les parties apicales sont engagées dans deux profondes dépressions correspondantes du tergite suivant. On ne

sait encore s'il s'agit là d'organes odoriférants ou d'organes sensoriels proprioceptifs. La même alternative se présente à propos des fossettes abdominales des Nabidés.

Mais, c'est avec les organes sensoriels de l'abdomen des Népidés que ces dernières paraissent être le plus comparables. Tous les Hétéroptères aquatiques de la famille des Népidés possèdent à proximité des stigmates, sur plusieurs segments de l'abdomen, des organes pairs, connus depuis longtemps; leur nature sensorielle a été démontrée par Baunacke, qui les a étudiés de façon approfondie. La situation de ces organes sur les latérotergites ventraux des urites 4 à 6 chez les imagos, et 3 à 6 chez les larves est identique à celle des fossettes parastigmatiques des Nabinae; la conformation de ces dernières est très proche de celle des organes des larves de *Nepa*, organes constitués par des cupules tégumentaires pourvues de soies tactiles, et qui rappellent de façon frappante les fossettes du septième urite des imagos de *Nabis*. Les organes abdominaux des Népidés sont considérés comme des organes de sens statique, renseignant l'insecte en enregistrant les différences de pression de l'eau en plusieurs points de son abdomen.

Il est bien évident qu'une telle fonction ne peut être envisagée pour les fossettes tégumentaires des insectes terrestres que sont les Nabidés. Toutefois, si l'on considère que ces fossettes comportent une masse centrale de sécrétion, qui enrobe les portions apicales de nombreuses soies tactiles, on peut penser que celles-ci, enregistrant les déplacements de la masse par rapport au corps de l'insecte, forment un appareil sensoriel "statique" d'un type particulier.

Cependant, après que les fossettes parastigmatiques d'exemplaires de *Nabis* aient été brûlées avec la pointe fine d'un thermocautère, je n'ai constaté aucune modification d'attitude ou de comportement des insectes opérés, qui ont été observés durant plusieurs jours après leur opération. Il y aura lieu de reprendre ces expériences dans des conditions variées, et en utilisant des exemplaires de *Prostemma* ou d'*Alleorhynchus* dont les fossettes sont particulièrement différenciées. Jusqu'à présent, la signification physiologique de ces organes des Nabidés est énigmatique.

J'ai recherché, en vain jusqu'ici, des formations tégumentaires comparables chez des représentants de familles considérées comme voisines des Nabidés, et notamment chez les Anthocoridés. Une prospection méthodique plus étendue tant parmi les Nabidés que parmi d'autres Hétéroptères apportera peut être d'utiles indications sur la phylogénèse de ces Insectes.

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<sup>1</sup> Bien que Kirkaldy, se basant sur d'autres caractères, ait rapproché dans son système de classification (1908) *Nabidae* et *Nepidae* dans le groupe des *Nepoideae*, il semble que ces familles sont par ailleurs trop différentes pour que la ressemblance signalée ici de leurs organes tégumentaires abdominaux, puisse les faire considérer comme phylogénétiquement voisines.

## CONCEPTION HISTOPHYSIOLOGIQUE DES GLANDES RÉTROCÉRÉBRALES DES INSECTES

Par P. Cazal

Les glandes rétrocébrales des Insectes offrent un exemple remarquable des corrélations neuro-humorales déjà si nettement établies chez les vertébrés et l'homme. Elles comprennent deux paires d'organes, les corps paracardiaques (ou corpora cardiaca) et les corps allates (ou corpora allata) innervés par les nerfs paracardiaques venant du protocérébrum.

### 1°) *Les corps paracardiaques*

Ils ont une structure extrêmement complexe, qui n'a pas été encore élucidée complètement. Ils comprennent des fibres nerveuses, des cellules chromophiles qui ne sont probablement que des cellules gliales banales, et surtout des cellules chromophiles très particulières sur lesquelles il convient d'insister. Elles sont bien apparentes grâce aux affinités tinctoriales de leur cytoplasme : éosinophilie, ponceauphilie ou fuchsinophilie après les fixateurs habituels, forte hématoxylinophilie après les fixateurs osmiés, osmophilie enfin. Ce cytoplasme est également très caractéristique par ses prolongements, au nombre de deux à quatre, qui se ramifient très rapidement. Il est difficile de les suivre sur les coupes en raison de leur sinuosité et de leur intrication. Ils paraissent cependant très longs. Certains se terminent par un bouquet de ramifications soit frêles et filiformes, soit renflées en massues. Les renflements claviformes ont parfois tendance à se grouper sur la membrane d'enveloppe, tournées soit vers la lumière du vaisseau dorsal, soit vers l'extérieur. Ces prolongements ont été nettement décrits et figurés chez les Phasmes par Pflugfelder<sup>1</sup> (1937). Je les ai observés dans la plupart des groupes d'insectes<sup>2</sup>.

Le cytoplasme des cellules chromophiles est riche en corps figurés. Les mitochondries sont abondantes, granuleuses, assez grosses, réparties d'une façon homogène et dense, même dans les prolongements. Les dictyosomes se mettent facilement en évidence par les imprégnations osmiques; ils sont annulaires ou en écailles, avec une substance sombre externe et une substance claire interne. Ils n'existent pas autour du noyau.

La sécrétion se fait dans ces éléments sous forme de boules chromophiles apparaissant dans les prolongements, surtout dans leurs parties distales. Ces dernières, bourrées de substance chromophile, semblent se détacher, ce qui réalise une sécrétion méro-holocrine.

Entre les différents éléments cellulaires des corps paracardiaques se trouvent de nombreuses formations, de taille et de forme diverses, aussi chromophiles que les prolongements. Ce sont probablement des gouttelettes ou des amas de produit sécrété, ainsi que l'avait pensé De Lema<sup>3</sup> (1937).

Les études embryologiques ont montré que les corps paracardiaques ont une origine identique à celle du ganglion hypocérébral. Leurs cellules chromophiles ont été interprétées soit comme des neurones véritables, soit comme des cellules sécrétrices. A notre avis, il s'agit là d'éléments *neurosecrétors*, neurones qui ont perdu leur pouvoir conducteur et qui ont développé au maximum leurs capacités sécrétrices. Une confirmation

<sup>1</sup> *Zeitschr. f. Wiss. Zool.*, 149, 477—512, 1937.

<sup>2</sup> *Les Glandes rétrocébrales des Insectes*, Thèse Paris 1947, et *Bull.-Biol. suppl.* XXXII, 1948.

<sup>3</sup> *Arch. Zool. ital.*, 24, 339—366, 1937.

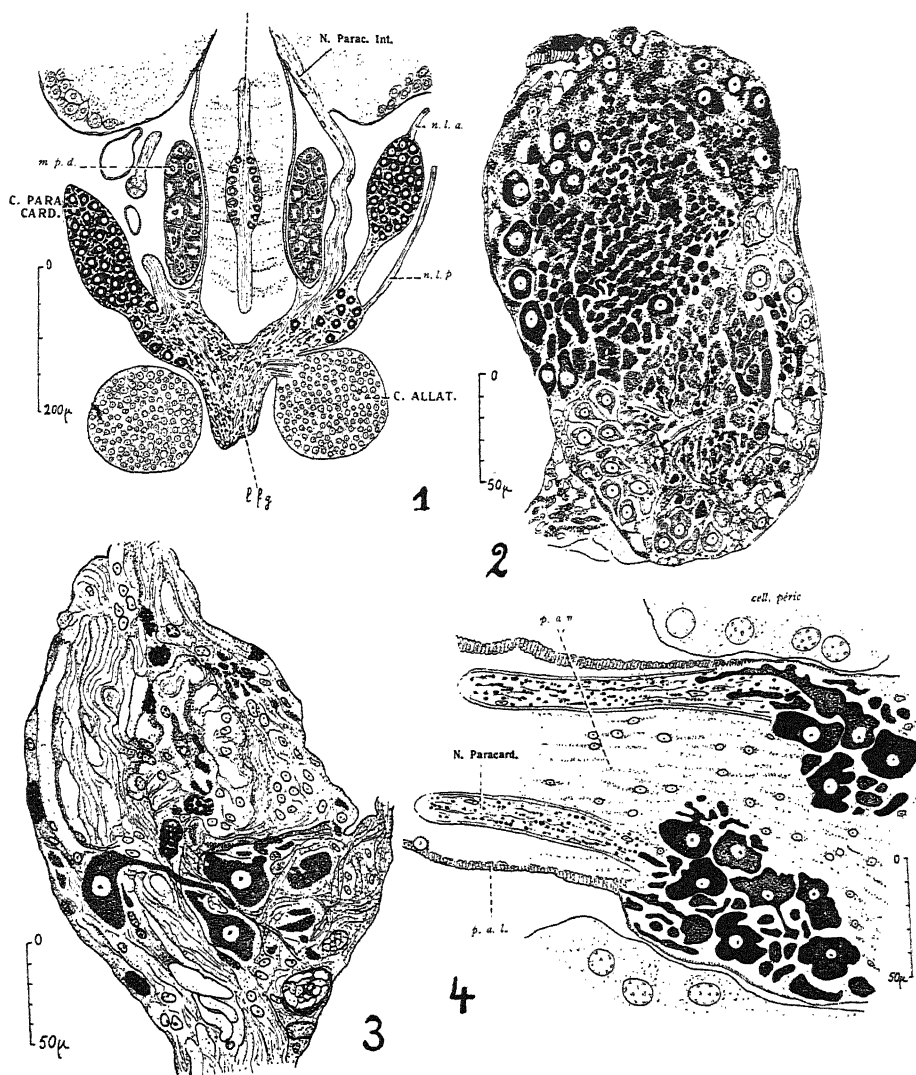


Fig. 1. Aspect général des glandes rétrocébrales de *Naucoris*. Coupe horizontale fixée au Champy et colorée pâl'hématoxyline.

Fig. 2. Corps paracardiaque de *Nepa*. Coupe horizontale; Champy-hématoxyline.

Fig. 3. Corps paracardiaque de *Hylotus*. Coupe horizontale; Champy-hématoxyline.

Fig. 4. Corps paracardiaque d'*Eristalis*. Coupe horizontale; Champy-impregnation osmique.

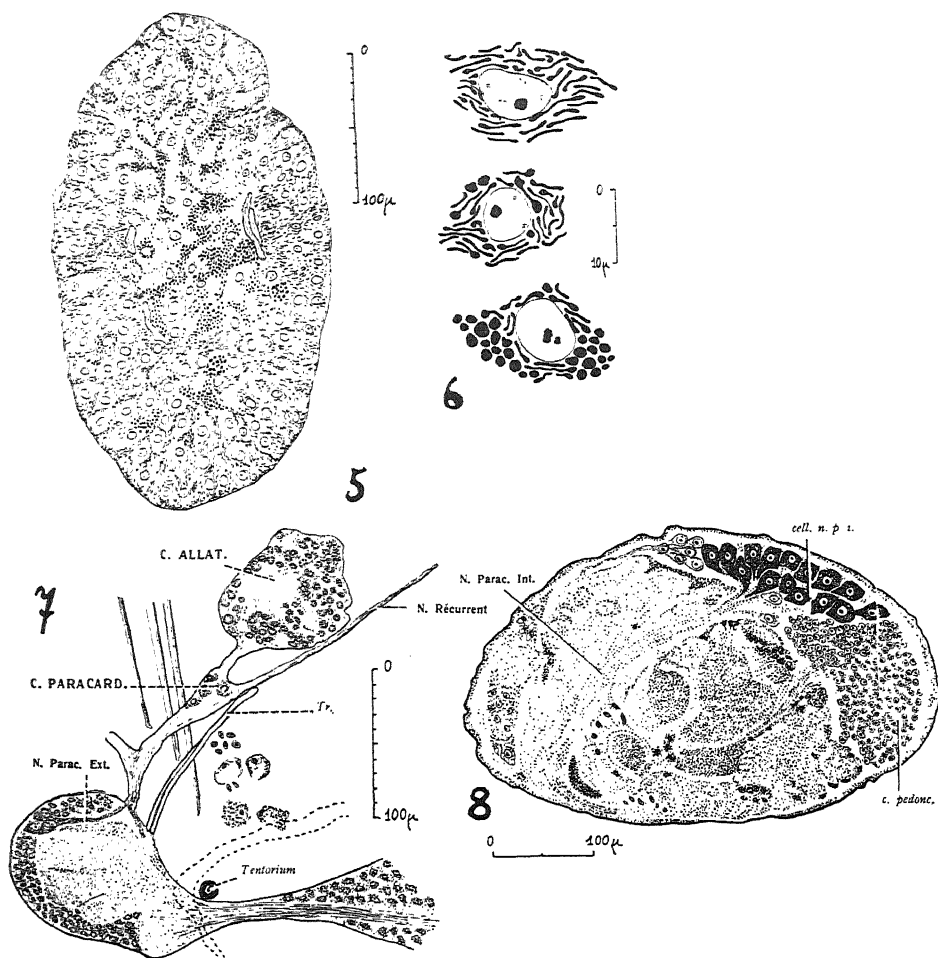


Fig. 5. Corps allate de *Metrioptera*. Champy-hématoxyline.

Mitochondries et grains de sécrétion.

Fig. 6. Sécrétion d'origine mitochondriale dans un corps allate d'*Eristalis*.

Fig. 7. Corps allate géant d'une femelle adulte de *Pulvinaria*.

Fig. 8. Cerveau de *Tipula*, coupe parasagittale montrant les cellules originelles du nerf paracardiaque interne (cell. n. p. i.).

de cette interprétation sera donnée par l'étude des cellules neuro-sécretrices du proto-cérébrum.

## 2°) Les corps allates

La structure des corps allates est beaucoup plus simple. Ils sont constitués par des cellules épithéliales, toutes identiques entre elles, dont on connaît bien l'histogénèse à partir de l'ectoderme ainsi que l'avait déjà montré Heymons<sup>4</sup> en 1899. Selon les groupes, les cellules allates sont plus ou moins nombreuses et de plus ou moins

<sup>4</sup> Sitz. Akad. wiss. Berlin, 30, 563—575, 1899.



grande taille. Chez certains, une cavité centrale persiste, vestige de l'organe ectodermique; mais dans la plupart des cas, ce sont des formations pleines.

La sécrétion des corps allates présente, en moins net, les mêmes caractères tinctoriaux que celle des corps paracardiaques. Son origine est cependant différente. Les gouttelettes de sécrétion se forment à partir de mitochondries filamenteuses dont les extrémités se renflent et grossissent progressivement. On observe parfois le passage de la sécrétion dans les espaces intercellulaires, puis elle paraît diffuser dans le milieu intérieur sans adopter de voie particulière. Parfois cependant, si le corps allate est en contact étroit avec l'aorte, elle peut se répandre dans celle-ci à travers des cellules spécialisées de la paroi vasculaire ("Durchlasszellen" décrites par Pflugfelder).

Les corps allates présentent des modifications de taille selon l'état fonctionnel des individus. Ils sont particulièrement développés chez les reines des Termites et surtout chez les femelles adultes des Cochenilles; dans ce dernier cas, ils sont aussi volumineux que le cerveau.

### 3°) *Les cellules neuro-sécrétrices du cerveau*

Les deux paires de nerfs paracardiaques prennent leur origine dans des neurones particulièrement intéressants du protocérébrum. Peu différenciés dans certains groupes où ils sont analogues aux autres cellules nerveuses, ils acquièrent par contre dans d'autres groupes des caractères sécréteurs. Ils sont alors de grande taille et leur cytoplasme abondant est rempli d'une substance ayant les mêmes caractères tinctoriaux que la sécrétion paracardiaque : acidophilie et ponceaophilie après les fixations banales, osmiophilie.

Cette sécrétion est surtout abondante dans les cellules originelles des nerfs paracardiaques internes, situées dans la pars intercerebralis. On peut en observer de fines gouttes dans les nerfs paracardiaques, le long desquels elles paraissent migrer.

De nombreux auteurs (Hansson<sup>5</sup>, Thomsen<sup>6</sup>, Scharrer<sup>7</sup>) ont déjà souligné l'analogie du système rétro-cérébral des Insectes et de l'hypophyse des Vertébrés : tous deux constitués par une partie neurosécrétrice et une partie épithéliale, ils sont innervés par des cellules spécialisées du cerveau (cellules protocérébrales des Insectes, cellules hypothalamiques des Vertébrés). Cette analogie frappante se retrouve sur le plan physiologique pur. Il y a là un remarquable phénomène de convergence créant, à partir d'organes bien différents, des structures analogues ayant des fonctions presque identiques.

<sup>5</sup> *Lunds Univ. Arssk.*, 37 1—19, 1941

<sup>6</sup> *Meig. Vid. medd. Dansk. natur. for.*, 106, 405 p., 1942

<sup>7</sup> *Biol. Bull.*, 87, 242—251, 1944.

## SUR L'ANATOMIE ET LE DÉVELOPPEMENT D'UNE BLATTE VIVIPARE

Par Lucien Chopard

L'espèce sur laquelle ont été faites les observations relatées dans cette note est une Blatte de la sous-famille des *Perisphaerinae*, le *Gromphadorhina laevigata* Sauss. et Zehntn. Les *Gromphadorhina* sont de grandes espèces, aptères dans les deux sexes, très caractéristiques de la faune de Madagascar; le genre est, en effet, confiné dans la Grande Ile, à l'exception d'une espèce (*G. javanica*), décrite de Java par Hanitsch, en 1930. D'après les documents de collections, les *Gromphadorhina* semblent se trouver à peu près partout à Madagascar, mais on n'a que fort peu de renseignements sur leurs mœurs dans leur pays d'origine. Quelques indications font simplement savoir qu'on les trouve souvent dans le bois pourri et font supposer que ce sont des Insectes de forêt.

Les individus que j'ai étudiés en captivité m'ont été envoyés de la région de Tuléar, en 1936, par le regretté naturaliste André Seyrig. Depuis cette époque et malgré les difficultés résultant des événements, j'ai réussi à toujours conserver cet élevage et en ai obtenu environ douze générations, le développement complet demandant à peu près un an. J'ai quelque peu hésité sur le nom à attribuer à cette espèce que j'avais cru tout d'abord pouvoir rapporter à *Gromphadorhina coquereliana* Saussure, sa taille moyenne se rapportant mieux à cette espèce qu'à la très grande *G. portentosa* Schaum. J'ai pu constater depuis que le pronotum de *G. coquereliana* est régulièrement arrondi en avant, alors que l'espèce que j'avais en élevage montre un pronotum très nettement tronqué au milieu du bord antérieur. Je pense donc pouvoir la rapporter à la forme décrite par Saussure et Zehntner sous le nom de *laevigata*, cette forme ayant les caractères de *portentosa* mais plus petite et à téguments moins fortement granulés.

Les *Gromphadorhina* ont le corps plus ou moins couvert de granulations un peu écailleuses, abondantes surtout sur les côtés du thorax et de l'abdomen; leurs antennes sont très épaisses chez les mâles; leurs pattes sont robustes comme celles des *Panesthia* qui vivent dans le bois pourri. Bien que les deux sexes soient complètement aptères,

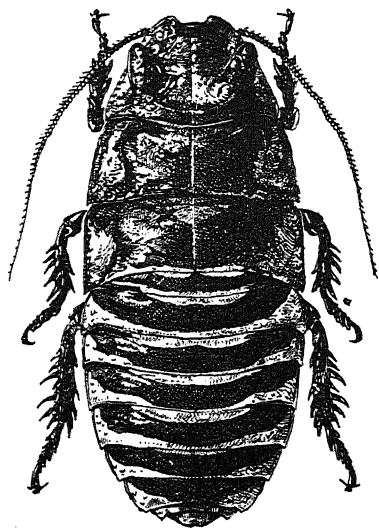


Fig. 1. *Gromphadorhina laevigata* Sauss. et Zehntn.,

on les reconnaît très facilement à la forme des derniers sternites abdominaux; chez les mâles, il y a 9 sternites, le 8<sup>e</sup> à bord postérieur très échancré, le 9<sup>e</sup> formant une petite plaque sous-génitale, portant deux styles grêles, symétriques; chez les femelles, c'est le 7<sup>e</sup> sternite qui forme la plaque sous-génitale comme chez toutes les Blattes; cette plaque est grande, à bord postérieur assez régulièrement convexe, ne portant pas de styles à l'état adulte. De plus, les mâles adultes (fig. 1) présentent sur le pronotum une grande excavation, entourée en arrière d'un bourrelet en fer à cheval, se terminant de chaque côte, en avant, par un gros tubercule arrondi. Chez les femelles, le pronotum est simplement déprimé, sans tubercules saillants. Les tubercules du mâle sont extrêmement variables suivant les individus et relativement beaucoup plus volumineux chez les mâles de grande taille que chez les petits. Par exemple, un petit mâle de 47 millimètres de longueur porte des tubercules de 3,2 millimètres; un grand mâle, long de 66 millimètres, a un pronotum bien plus profondément excavé et muni de gros tubercules saillants, de 6 millimètres. C'est un cas d'allométrie assez comparable à ce que présentent les mandibules des Lucanes.

Il est naturellement plus difficile de reconnaître les sexes des jeunes individus qui ont des caractères très voisins chez le mâle et la femelle. Les jeunes femelles portent en particulier des styles au 9<sup>e</sup> sternite; mais celui-ci est profondément divisé au milieu du bord postérieur et en partie recouvert par le 7<sup>e</sup> sternite, tandis que le 8<sup>e</sup> est invaginé de bonne heure; les jeunes mâles, au contraire, ont le 8<sup>e</sup> sternite à bord postérieur concave, dégageant bien le 9<sup>e</sup> qui n'est pas échancré.

L'élevage des *Gromphadorhina* ne présente pas de difficultés; comme pour toutes les Blattes, il leur faut une certaine humidité et une nourriture mélangée de substances hydrocarbonées et de feuilles vertes ou fruits; la température la plus favorable semble pouvoir être fixée entre 20 et 25° C., mais une température plus élevée ne paraît pas réduire la durée du développement qui est toujours très long. Ces Blattes présentent, quand on les saisit une curieuse réaction, consistant en émission d'air par les stigmates thoraciques, avec production d'un bruit caractéristique. Ce bruit est assez curieux pour avoir été remarqué par les indigènes de Madagascar qui, pour cette raison, leur donnent le nom de kofokofoka, qui semble être une onomatopée.

Mais, le point le plus intéressant de la biologie des *Gromphadorhina* est présenté par l'incubation des oeufs et l'éclosion des jeunes. Comme beaucoup de *Perisphaerinae*, les espèces de ce genre sont vivipares; le fait est facile à établir mais les détails de l'incubation et de la naissance des larves n'ont jamais été observés et ce n'est qu'après plusieurs années d'élevage que j'ai pu en préciser les modalités. On voit de temps à autre dans les élevages une femelle portant une oothèque membraneuse qui fait plus ou moins saillie à l'extrémité du corps. Il arrive parfois que cette oothèque, longue de 3 centimètres environ, est expulsée par la femelle et on observe alors que les oeufs qu'elle contient ne se développent pas. Chaque fois qu'une oothèque a été ainsi abandonnée par la femelle dès sa formation, les oeufs se sont desséchés, quelles que soient les conditions dans lesquelles ils ont été placés, et ils n'ont jamais éclos.

Ce n'est que récemment que j'ai réussi à observer le processus normal de la ponte et de l'incubation chez les *Gromphadorhina*. La première observation fut faite au Vivarium du Jardin des Plantes de Paris en juillet 1947, la seconde en février 1948; toutes deux concordent entièrement. Une femelle présente à l'extrémité de l'abdomen une oothèque semblant toute prête à expulser (fig. 2); d'abord, faisant à peine saillie, elle sort de plus en plus de l'abdomen, arrivant à être presque complètement détachée. Ce travail dure plusieurs heures et l'oothèque dépasse l'extrémité de l'abdomen de

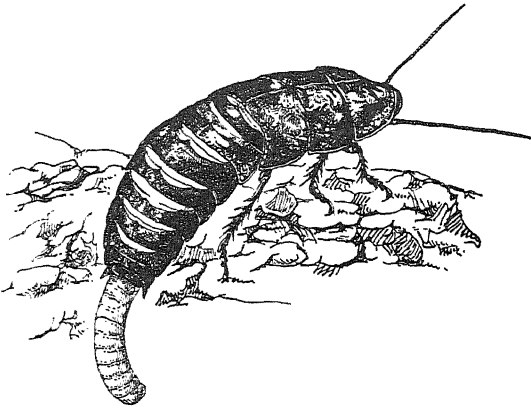


Fig. 2. Femelle de *Gromphadorhina laevigata* portant son oothèque au moment où celle-ci va rentrer dans la poche incubatrice.

25 millimètres environ. Mais, alors qu'elle ne tient plus que par son extrémité, le mouvement inverse se produit et l'oothèque rentre lentement dans le corps ou plus exactement dans la grande poche incubatrice qui se trouve sous les organes génitaux et qui s'avance jusque dans le métathorax. La ponte est terminée et l'incubation commence; celle-ci dure environ 70 jours. Dans le premier cas, la ponte fut observée le 22 juillet et l'éclosion le 1<sup>er</sup> octobre (70 jours); le second cas d'incubation dura du 12 février au 22 avril (69 jours). La naissance des jeunes, à la fin de la période d'incubation, prend un certain temps. J'ai observé une femelle prête à évacuer ses jeunes le 30 août 1946; l'abdomen est fortement gonflé et distendu; à l'extrémité apparaît une oothèque mince, laissant voir un jeune prêt à sortir. La femelle est isolée et, le lendemain, je trouve un seul jeune, mort auprès d'elle; l'abdomen est redevenu plus normal. Ce n'est que deux jours après, le 1<sup>er</sup> septembre au matin, que tous les jeunes sont éclos. La femelle n'aide en aucune façon à la sortie des petites larves, mais celles-ci restent groupées auprès d'elle pendant un certain temps après l'éclosion. La mère se tient alors immobile, dressée sur les pattes, le thorax un peu bombé, faisant place à sa nichée (fig. 3).

La longueur des oothèques est de 30 à 32 millimètres; elles sont blanchâtres, à parois membraneuses très minces. Le nombre des oeufs contenus dans chacune d'elles semble assez variable; sur une oothèque expulsée prématurément, j'ai compté 61 oeufs, alors que les éclosions de jeunes m'ont donné des chiffres variant de 32 à 48. Peut-être un certain nombre d'oeufs sont-ils arrêtés dans leur développement. Les jeunes effectuent une mue aussitôt après l'éclosion; ils ont alors une longueur de 8 millimètres et sont d'une couleur uniforme grise; après la seconde mue, ils deviennent plus noirs et plus luisants, puis montrent des taches jaunâtres, assez vives, sur le thorax et sur l'abdomen. Le nombre total des mues est de 7 ou 8.

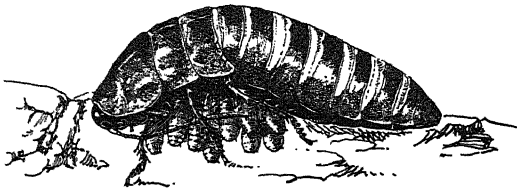


Fig. 3. Femelle de *Gromphadorhina laevigata* entourée de ses jeunes venant d'éclore.

Si l'on cherche à préciser la position de la poche incubatrice dans l'abdomen, on voit qu'elle est placée immédiatement sous l'utérus avec lequel elle a des rapports étroits; mais sa dimension est bien différente chez une jeune femelle, avant la ponte, et chez une femelle gravide. Dans le premier cas (fig. 4), c'est une poche courte, à parois épaisses, plissées, n'occupant dans l'abdomen qu'une place très réduite. Dans le second cas (fig. 5—6), la poche incubatrice, dont les parois sont devenues très minces, est énorme, s'étendant jusqu'au métathorax dans lequel elle pénètre; elle occupe ainsi toute la partie gauche de l'abdomen, refoulant tous les organes vers la droite, sauf l'ovaire gauche qui est déplacé vers le bas, l'oviducte correspondant passant sous la poche. Les deux oviductes, se réunissent en un oviducte commun qui se dilate en un utérus arrondi, assez volumineux; dans cet utérus débouchent la spermathèque et deux

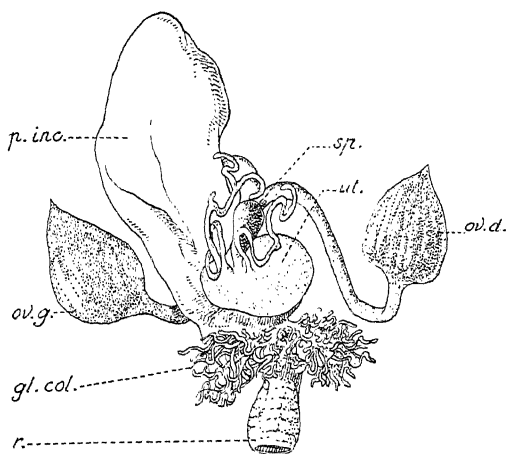


Fig. 4. Organes génitaux et poche incubatrice d'une jeune femelle de *Gromphadorhina laevigata*.—p. inc., poche incubatrice; s. p., spermathèque; ut., utérus; ov. d., ovaire droit; ov. g., ovaire gauche; gl. col., glandes collatérales; r., rectum.

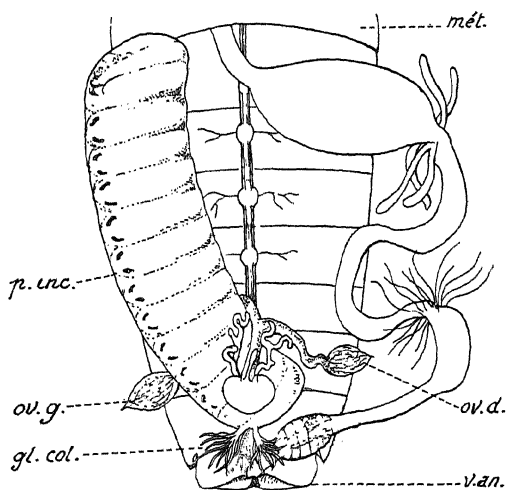


Fig. 5. Oothèque en place dans la poche incubatrice.—mét., métathorax; p. inc., poche incubatrice; ov. d., ovaire droit; ov. g., ovaire gauche; gl. col., glandes collatérales; v. an., valves anales inférieures (paraproctes).

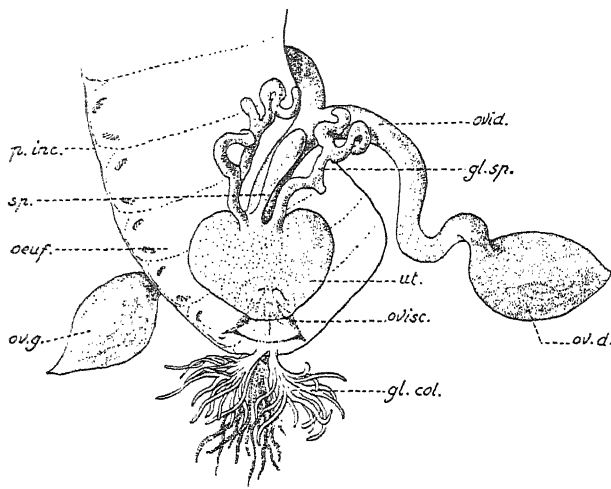


Fig. 6. Extrémité inférieure de la poche incubatrice et ses rapports avec les organes génitaux chez une femelle gravide.—p. inc., poche incubatrice; ovid., oviducte; ov. d., ovaire droit; ov. g., ovaire gauche; s.p., spermatheque; ut., utérus; ovisc. oviscapte; gl. col., glandes collatérales.

tubes glandulaires peu ramifiés, blanchâtres; plus en arrière se trouvent les glandes collatérales, formant trois groupes de tubes très divisés, le médian à tubules plus minces et moins colorés en blanc que les latéraux. Il y a dans le vestibule génital trois orifices, celui de l'utérus, ou gonopore, en avant, celui des glandes collatérales en arrière, et celui de la poche copulatrice en dessous. Il faut enfin signaler la position tout à fait anormale de l'oviscapte chez les femelles gravides; cet organe est en effet complètement retourné, l'extrémité des valves à l'intérieur du corps au lieu d'être dirigées vers l'extérieur; il est probable que ce retournement se produit au moment où l'oothèque pénètre dans la poche incubatrice. Indiquons enfin que Shelford avait déjà signalé la présence de la poche incubatrice chez *Panesthia javanica* (Trans. ent. Soc. London, 1906, p. 509) et il est probable que cet organe existe chez toutes les espèces vivipares.

### Résumé

Chez la Blatte vivipare *Gromphadorhina laevigata*, l'oothèque semble formée comme chez les autres Blattes, mais au moment d'être expulsée, elle rentre dans la poche incubatrice où les oeufs demeurent 70 jours environ. Ce séjour est indispensable au développement normal des oeufs. Les jeunes restent quelque temps auprès de leur mère après l'éclosion ce qui indique une tendance vers un gréganisme relatif. La poche incubatrice occupe tout le côté gauche de l'abdomen, jusqu'au métathorax; l'oviducte gauche passe sous elle; l'oviscapte se trouve complètement retourné quand la poche est remplie par l'oothèque.

## ON THE FACTOR INDUCING THE DORMANCY OF THE RICE BORER, *CHILO SIMPLEX* BUTLER

By *M. Fukaya*

### *Introduction*

Distributed over south-eastern Asia, the rice borer, *Chilo simplex* Butler is known as one of the most serious pests of the rice plant. It emerges twice a year, and great damages are often brought about by the second generation larvae in autumn.

It is generally considered that the damage in the first generation is influenced by the time when the imagoes appear, while in the second generation, by the number of insect breaking out.

Up to the present, much effort has been given to statistical method, especially, in forecasting the time and number of imagoes emerging in a season. Thus, the attention would be drawn upon the possible presence of an influencing effect of the dormancy of second generation larvae upon the time of emergence of the first generation in the following year.

The term dormancy has been used to denote the apparent cessation of the physiological development of an organism. In fact, however, it is hard to determine a true dormancy of an organism, as the physiological state of the organism is not easily grasped by appearances alone. The writer has come to believe in the case of the rice borer, that the dormancy is a state characterised by the inactiveness of the physiological process leading to pupation. Dormancy of the borer is believed to be induced generally in late autumn, but actually, it is commonly found in the larvae of the first generation as well as in the second when the environmental temperature is yet sufficiently high.

This paper attempts to present the results obtained from some physiological studies on larvae in the second generation, with special reference to the mechanism inducing the dormancy of the larvae.

### *Material and Methods*

The rice borers used in this experiment were gathered in Okayama-Ken, where the dormancy of the larvae is so pronounced in winter. The eggs for the experiment were so called "last night's eggs" laid by females collected by attracting to a fluorescent light in rice fields and allowed to lay eggs on paper in the laboratory. The larvae were reared in small glass tubes held in a saturated humidity. The test tube method was used for breeding larvae. The larvae, just after hatching, were cultured individually by feeding stems of rice plant cut 10 to 12 cm long, freshly supplied, usually, every two days. In order to prevent larvae from escaping and to maintain high humidity, the tubes were set upside down.

Eggs were subjected to different temperatures as the experiment required, but the breeding conditions for the larvae were always held constant. For the effect of light, eggs were either placed in the dark or in the light. The number of moulting was recorded at the time when the feed stems were renewed.

*Experiments and Discussion*

The younger larvae taken from fields early in September will easily develop until they attain the fifth instar, shortly after placing them in an incubator regulated to a temperature of from 25 to 32° C, but none of them will pupate so early as they will be expected. This may due to the larvae's state of dormancy, but how such dormancy has been brought about is a problem to be determined and requires investigation. Experiments were conducted, using the larvae reared from eggs which have previously been subjected to different temperatures, to determine the effects of such treatment upon the percentage of pupation, length of larval period and duration of each of the instars of the larvae.

Table I. *Pupation as Affected by the Conditions in the Egg Stage.*

Temperature exposed on eggs (° C)	Temperature exposed on larvae (° C)	Number of materials tested	Percent pupation
22.0 (Dark)	32.0	26	0
27.0 (Dark)	31.0	49	16.1
29.7 (Dark)	31.0	31	32.3
31.0 (Dark)	31.0	105	45.7
31.0 (Light)	31.0	63	42.9
33.3 (Light)	31.0	23	4.4

Note: Percent pupation was recorded at 50 days after hatching.

Table II. *Length of Larval Period as Affected by the Condition in the Egg Stage.*

Section	Temperature exposed on eggs (° C)	Number of materials tested	Length of larval period (days)
A	31.0 (Light)	5	21.6 ± 2.0
A'	31.0 (Dark)	11	23.1 ± 1.4
B	31.0 (Light)	17	20.5 ± 1.2
B'	29.7 (Dark)	17	20.2 ± 1.3
C	31.0 (Dark)	17	22.8 ± 0.8
C'	27.0 (Dark)	8	23.5 ± 1.4

Note: A, A'; B, B'; and C, C' are one half of an egg mass respectively.

Table III. *Instar Duration as Affected by the Conditions in the Egg Stage.*

Temperature exposed on eggs (° C)	Number of larvae tested	Number of ecdysis	Instar duration in days				
			1	2	3	4	5
31.0 (Dark)	5 (Non-pupated)	4	3.2	4.0	6.0	17.2	—
	15 (Pupated)	4	3.2	2.9	2.8	5.2	9.7
27.0 (Dark)	12 (Non-pupated)	4	2.0	4.0	6.7	15.3	—
	3 (Pupated)	4	2.7	3.3	4.0	4.7	8.0

Note: This table is a result on surviving larvae 50 days after hatching. The breeding temperature of larvae was 31.0° C.



The foregoing Table I and III clearly indicate that the length of larval stage is affected by the temperature at the egg stage. When the eggs are kept at a temperature below  $22^{\circ}\text{C}$ , larvae that follow will enter a normal dormancy. Non-dormant individuals appear for the first time when the condition for the eggs is  $27^{\circ}\text{C}$ ; and at  $31^{\circ}\text{C}$ , the percentage of pupation reaches a maximum. On the other hand, the condition of darkness during the egg stage seems to give a higher percentage of pupation than when light, but their effects upon eggs were not sufficiently investigated.

Unaffected by the egg condition, there were no differences observed in the duration of larval period among those that failed to enter dormancy (Table II).

The duration of instar differed between the larvae that entered the dormancy and those that failed, and it is apparently recognizable that the larvae's duration of instar upon those that entered dormancy is longer after third instar than those that pupated.

From the above results, the physiological condition that produces dormancy is initiated early in the development of the insect rather than the sole conditions of the fourth or the fifth instar that coincides with the entrance into dormancy. A similar result, proving that the temperature at a certain stage in the development of an insect affects the subsequent physiological state, has been observed by Dr. Kogure (1932) in the silk-worm. He assumed that there exists a certain substance inducing the dormancy, and named it the hibernation substance. This substance is considered to increase in amount during the pupal period by means of high temperature, but destroyed after egg stage.

Contrary to the rice borer, Babcock (1927) pointed out that the inception of the dormancy in the corn borer will not be initiated by a lowering of the temperature, while Kozhanchikov (1938) succeeded in inducing the dormancy of this borer solely by low temperature.

Although the dormancy is partly controlled by the environmental condition, one cannot deny that there may also exist an inner tendency which decides the physiological state of an animal unaffected by the external condition. In the case of the rice borer, however, low temperature being a definite factor controlling the induction of the dormancy, it can be concluded that the rice borer occurs only twice a year in areas where the second generation eggs in autumn are naturally exposed to temperatures below  $27^{\circ}\text{C}$ .

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## INFLUENCE DE LA TEMPÉRATURE SUR L'ACTIVITÉ DU DORYPHORE (*Leptinotarsa decemlineata* Say) AU STADE IMAGINAL

Par P. Grison

Les travaux écologiques des entomologistes américains, puis ceux de B. Trouvelot et de ses collaborateurs et de Mayné et de ses collaborateurs, enfin de M. Boczkowska fournissent d'abondantes indications sur le comportement et la prolifération de *L. decemlineata* en fonction du climat.

Depuis plusieurs années nous nous préoccupons de préciser les caractères de la diapause chez le Doryphore adulte et ces recherches nous ont amené à étudier au laboratoire l'action des facteurs externes sur l'imago.

Dans cette note nous donnerons un bref aperçu des principaux résultats que nous avons obtenus en étudiant plus spécialement l'action de la température.

### I. Influence de la température sur l'activité des Insectes parfaits après la diapause.

B. Trouvelot (1936) a déjà indiqué que les sorties principales d'adultes avaient lieu au printemps, lorsque la température moyenne de l'air atteignait environ  $+15^{\circ}\text{C}$ .

A cette dernière correspond généralement un réchauffement du sol jusqu'à  $+12^{\circ}\text{C}$  à 5 cm de profondeur et en moyenne à  $+10^{\circ}\text{C}$  au moment du début des sorties d'adultes hibernants. Nous avons donné quelques dates (P. Grison et M. Chevalier 1944) auxquelles ces températures sont atteintes et qui se situent généralement vers le 20 avril à Versailles, mais souvent beaucoup plus précocement pour quelques sorties exceptionnelles, lorsqu'il y a des réchauffements temporaires et locaux du sol, en hiver ou au début du printemps.

Lorsque des Insectes hibernants, enfouis à la même période automnale, sont maintenus à la température constante de  $15^{\circ}$  à  $18^{\circ}\text{C}$ , la sortie s'échelonne, à partir du mois de janvier, pendant deux à trois mois en raison des grandes variations individuelles de réaction des animaux aux facteurs externes. Ce fait est encore plus marqué dans la nature, où les fluctuations de température provoquent le grand échelonnement de sorties que nous avons signalé (P. Grison 1939).

2) *Activité générale. Déplacements et vols.* Le 8 juin 1948 on a assisté, dans le Nord-Ouest de l'Europe, à l'un des vols les plus considérables parmi ceux observés jusqu'ici depuis la venue du Doryphore en Europe. Il s'en était produit en 1936 dans le Centre-Est de la France, qui avaient fait progresser l'Insecte jusque vers la Rhénanie (fig. 1 et 2); en 1939 il en avait été signalé sur les côtes du Morbihan d'où l'Insecte gagna Belle-Ile en Mer; en 1947 enfin, un phénomène de même nature se produisit dans la zone de l'Île de Jersey. A chaque fois, ces vols importants sont consécutifs à une forte élévation de la température succédant à des températures modérées et de faible amplitude et précédant immédiatement des orages provoqués par de brusques perturbations barométriques.

Par exemple à Lille, en juin 1948, les températures maxima s'étaient progressivement élevées de  $+16^{\circ}$  le 4 juin à  $+19^{\circ}\text{C}$  le 6,  $+21^{\circ}\text{C}$  le 7 et  $+30^{\circ}\text{C}$  le 8 juin, journée précédant l'apparition du système orageux qui s'est étendu le 10 juin sur la France septentrionale (fig. 3).

## PRONOSTICS DE DISPERSION PAR VOLS LES 13 ET 15 JUIN 1936

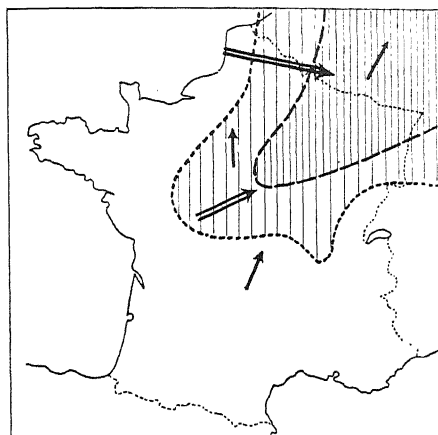


fig.1. 13 juin

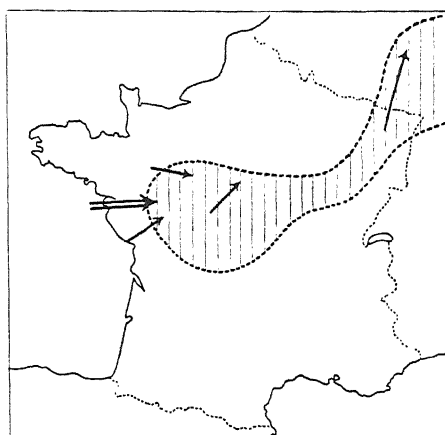


fig.2. 15 juin

- direction locale des vents  
 ==> sens du déplacement des systèmes nuageux et des basses pressions

La direction et la vitesse du vent agissent ensuite, lorsque les Insectes ont été incités à l'envol, pour conditionner le sens et l'amplitude de la dispersion (fig. 4).

D'une façon générale les déplacements à la marche ou au vol des individus isolés sont d'autant plus considérables que la température ambiante est plus élevée, ainsi que nous l'avons maintes fois constaté dans nos cages d'élevage au laboratoire.

La mesure de l'activité cinesthésique peut être faite à l'actographe de S z y m a n s k i modifié par C h a u v i n (1943) : la fréquence et l'amplitude des oscillations du stylet inscripteur permettent d'évaluer l'intensité de l'activité.

3) *Alimentation.* L'appétit des Doryphores varie énormément suivant la température. Sa mesure en est facile si l'on dispose d'une quantité suffisante d'étuves pour réaliser une échelle thermique assez grande. Nous avons effectué cette mesure sur trois individus isolés en boîte de Petri pendant trois jours en relevant la surface consommée d'une feuille de Pomme de terre de la variété Bintje toutes les douze heures, à 6 H et à 18 H (Heure solaire); l'humidité relative était d'environ 85 %. La consommation individuelle moyenne, exprimée en mm<sup>2</sup>, est la suivante :

à la température constante de	consommation nocturne	consommation diurne	consommation par 24 H.
8° C	0	0	0
10°	0	0	0
13°	98 mm <sup>2</sup>	120 mm <sup>2</sup>	218 mm <sup>2</sup>
16°	93 —	166 —	259 —
21°	143 —	279 —	422 —
25°	412 —	388 —	800 —
30°	261 —	162 —	423 —
35°	78 —	65 —	143 —

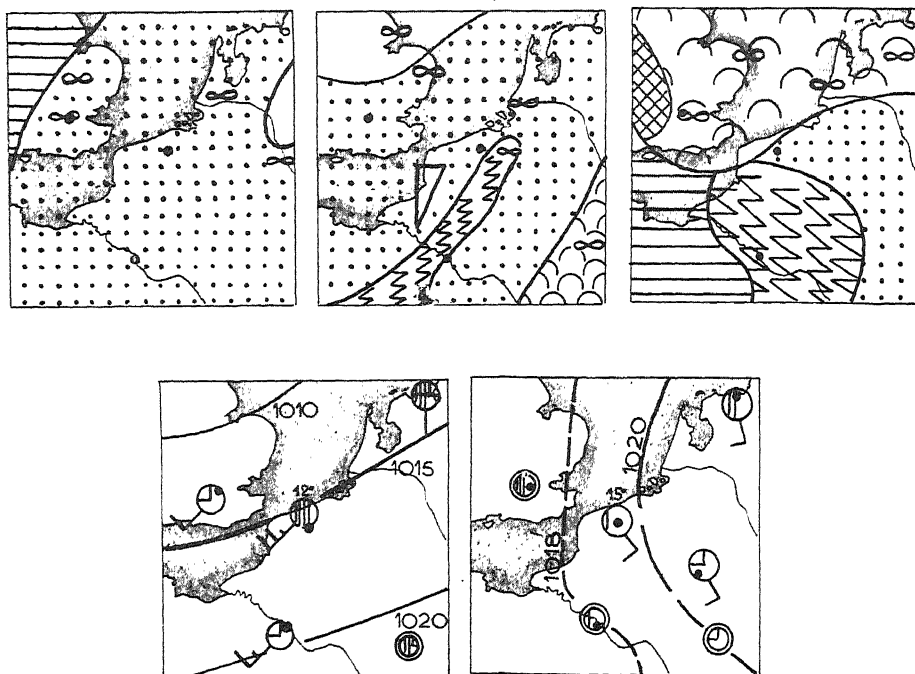


Fig. 3 et 4. Renseignements communiqués par le Bulletin quotidien de l'Etablissement Central de la Météorologie.

Zône avec pointillés : zone antérieure d'un système nuageux.

Zône avec traits sinueux : zone orageuse.

Zône avec quadrillé : zone centrale d'un système nuageux.

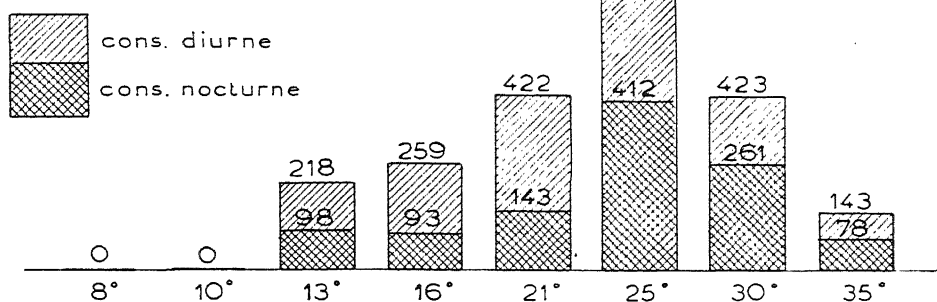
Il résulte de ces mesures (fig. 5) que le seuil thermique inférieur d'alimentation est plus élevé que celui d'activité cinesthésique puisque, tandis que ce dernier est inférieur ou voisin de  $+10^{\circ}\text{C}$  suivant les individus, le premier est supérieur à cette température et compris entre  $+10^{\circ}\text{C}$  et  $+13^{\circ}\text{C}$ . Le maximum de consommation est enregistré à  $+25^{\circ}$ , ce qui confirme la détermination de ce degré thermométrique comme température optimum d'élevage du Doryphore par de nombreux entomologistes (Swingle 1941, Grison 1942, ...). Un autre fait intéressant peut être tiré de ce tableau; en présence d'aliment l'insecte mange constamment, mais en observant un certain rythme nyctéméral qui s'inverse au-dessus de la température optimum.

Dans la nature, le rythme nyctéméral à activité diurne est très caractérisé en raison des abaissements nocturnes de température qui deviennent très importants dans les régions septentrionales.

Enfin les grosses différences de consommation par rapport à la température optimum, et qui, par degré et pour 100 mm<sup>2</sup> d'aliment consommé à  $25^{\circ}\text{C}$ , peuvent être de l'ordre de : 
$$\frac{(800-422)\text{mm}^2 \cdot 100}{(25-21^{\circ}) 800} = 11,8\%$$
 démontrent l'importance pratique des conditions climatiques sur la rapidité de destruction du feuillage de Pomme de terre par le Doryphore.

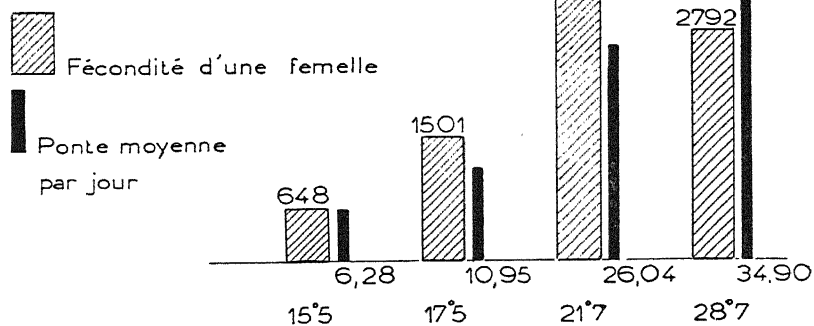
ALIMENTATION  
EN mm<sup>2</sup>  
EN FONCTION DE  
LA TEMPERATURE

fig. 5



FECONDITE ET  
PONTE MOYENNE  
EN FONCTION DE  
LA TEMPERATURE

fig. 6



4) *Activité reproductrice.* La fréquence des accouplements et celle des émissions d'oeufs sont étroitement liées à la température, bien que le degré hygrométrique ait également une grande influence que nous n'analysons pas ici. La ponte est facile à étudier en isolant des couples en petites caquettes d'élevage placées à différentes températures, et en comptant chaque jour le nombre d'oeufs déposés par la femelle.

Les Insectes parfaits printaniers sont ramassés accouplés au début du mois de mai; nous totalisons pour chaque condition étudiée, la ponte de cinq femelles et, tenant compte de la longévité de chacune d'elles, nous établissons la ponte moyenne par femelle et par jour.

Dans une expérience, à 100 % d'humidité relative, la ponte est nulle à  $+10^{\circ}\text{C}$  tandis qu'elle est de 617 oeufs en 113 jours (soit une moyenne de 5,46 OE.) à  $+18^{\circ}\text{C}$  environ.

Dans une autre expérience (fig. 6), à 80—85 % H. R., nous obtenons les résultats suivants :

Moyennes thermiques:	$15^{\circ},5\text{ C.}$	$17^{\circ},9\text{ C.}$	$21^{\circ},7\text{ C.}$	$28^{\circ},7\text{ C.}$
Ecart thermiques:	$+14^{\circ} +18^{\circ}$	$+16^{\circ} +20^{\circ}$	$+19^{\circ},5 +23^{\circ}$	$+27^{\circ} +30^{\circ}$
Ponte totale:	648 OE	1501 OE	3985 OE	2792 OE
Pontes min. et max.:	0 à 411 OE	130 à 429 OE	112 à 870 OE	151 à 1286 OE
Longévité totale:	103 jours	137 j.	153 j.	80 j.
Ponte moyenne par femelle et par jour:	6,28 OE	10,95 OE	26,04 OE	34,90 OE

Le seuil est difficile à préciser en raison des fortes variations individuelles, néanmoins il paraît être voisin ou sensiblement supérieur à celui que nous avons fixé pour l'alimentation : si la ponte, quoique très rare, est possible entre  $+12^{\circ}\text{C}$  et  $+15^{\circ}\text{C}$  le tableau ci-dessus montre qu'elle demeure faible entre  $+15^{\circ}$  et  $+18^{\circ}\text{C}$ .

D'après d'autres expériences, dans lesquelles les couples subissent pendant des périodes successives de 8 à 10 jours l'action de températures croissantes ou décroissantes nous pouvons établir que, par unité de temps, il y a une certaine proportionnalité entre le débit ovulaire et la température, comme le montre aussi l'expérience précédente.

Cependant, dans la plupart des cas, la fécondité totale d'une femelle présente un maximum à  $+25^{\circ}\text{C}$ ., en raison de la plus grande longévité des Insectes à cette température optimum. A  $+35^{\circ}\text{C}$  le Doryphore, Insecte thermophile, pond encore régulièrement; il en serait de même à  $+38^{\circ}\text{C}$  si la mort n'abrégeait considérablement la durée d'activité des individus des deux sexes.

Ces données ont évidemment une très grosse importance pratique. A une température élevée la prolifération du Doryphore peut être très forte et donner lieu à une rapide et brusque pullulation de l'Insecte surtout en première génération.

Au contraire, lorsque les températures moyennes atteignent rarement  $+18^{\circ}\text{C}$  pendant la saison printanière comme cela fut le cas en 1948, la fécondité des adultes hibernants est très réduite, malgré la longue survie de ces derniers, et leur descendance est relativement faible.

## II. *Phénomènes physiologiques indépendants de la température.*

Cependant, si la plupart des processus physiologiques qui caractérisent l'activité des Insectes parfaits printaniers sont étroitement liés à la température, le comportement des adultes de première génération, tel que nous l'avons décrit dans une série de notes antérieures depuis 1939, ne présente pas la même dépendance à l'égard des facteurs externes. Déjà Girault (1908), dans les controverses qu'il eut avec Tower,

remarquait que, dans la nature comme au laboratoire, la fécondité des adultes de première puis de seconde génération, toutes conditions égales d'ailleurs est beaucoup plus réduite que celle des adultes sortant de l'hibernation.

Bien que Swingle (1941) indique une technique permettant de maintenir le Doryphore en activité continue grâce à l'emploi d'une température d'élevage rigoureusement constante de  $+25^{\circ}\text{C}$ , il semble bien qu'il ne réussisse pas à éviter l'enfouissement d'une partie des adultes des générations successives et, d'autre part, les précautions thermiques que cet auteur recommande prouvent que l'activité générale ne varie plus en fonction de la température.

Certes il est possible d'obtenir, au laboratoire, plusieurs générations successives du Doryphore; cependant nous avons précisé (1944) qu'à chacune de celles-ci une fraction importante d'adultes s'enfouit et entre en diapause. Dans la nature, lorsque la température optimum ne se maintient pas suffisamment, comme dans les régions septentrionales de l'Europe et de l'Amérique, la totalité des adultes de première génération s'enfouit dans le sol une quinzaine de jours après la mue imaginale sans avoir déposé un seul oeuf.

Ces particularités nous ont permis de caractériser la diapause imaginale chez cette espèce; les divers facteurs externes que nous avons fait intervenir, dont la température, pendant la période de repos, ont été inefficaces pour obtenir la rupture de cette diapause.

Des expériences conduites par J. De Wilde à Amsterdam, et dont les résultats nous ont été aimablement communiqués par notre collègue, montrent que, malgré l'emploi d'une température d'élevage de  $30^{\circ}\text{C}$ , rigoureusement constante à  $\pm 0,5^{\circ}\text{C}$ , d'une hygrométrie optimum de 80 %, d'un éclaircissement permanent et suffisamment intense de 4.000 lux, d'une nourriture de choix avec du feuillage jeune, 50 % des imagos de première génération entrent en diapause.

Nous pensons, et nous l'avons signalé au Symposium sur l'Endocrinologie des Arthropodes qui s'est tenu à Paris en 1947, que la diapause vraie résulte d'un trouble du métabolisme qui affecte l'état physiologique de l'individu et qui met en jeu certaines corrélations humérales, sur la signification desquelles nous sommes encore peu renseignés. Ce n'est pas l'objet de cette note d'en discuter la nature et la portée.

Du point de vue écologique, lorsque la température sera trop faible, inférieure à l'optimum, au moment de l'apparition des adultes de première génération, ceux-ci s'enfouiront dès qu'ils auront satisfait leur appétit et ne donneront pas naissance à une seconde génération. Mais, si à ce moment la température est assez élevée et si les Insectes trouvent une nourriture abondante et appropriée, une seconde génération s'établira provenant du maintien en activité, et de la ponte, d'une proportion variable d'imagos venant d'apparaître. Exceptionnellement, il pourrait en être de même dans les contrées méridionales, ainsi que Melle. Boczowska (1945) l'a signalé, pour une troisième génération partielle ou réduite, à l'occasion de l'apparition des imagos de deuxième génération.

III. *Conclusions. Conséquences pratiques sur la prolifération du Doryphore et le nombre de ses générations.* Le potentiel d'activité générale du Doryphore, et notamment de son activité reproductrice au printemps, est fonction dans une large mesure de la température. L'importance de l'infestation printanière des champs de Pommes de terre par les imagos sortant d'hibernation puis par la descendance larvaire de ces derniers, dépendra donc des caractères climatiques des mois de mai et juin pendant lesquels les

déplacements, l'alimentation et la ponte de ces adultes peuvent être intenses. Au-delà de cette période et lorsqu'elle s'est caractérisée par des conditions défavorables, la puissance de destruction des Insectes sera réduite en raison de la grande mortalité survenant dès le mois de juillet parmi les adultes de l'année précédente.

Les graphiques écologiques représentés à la fig. 7 donnent une idée de cette action climatique. La population du Doryphore est dénombrée chaque année aux stades Imago hibernant, Oeufs de première génération, Imagos de première génération, puis individus de diverses générations, à cause du chevauchement de celles-ci, sur une parcelle de vingt pieds de Pomme de terre isolée dans le même terrain d'expérience.

Les courbes de ponte suivent à peu près les fluctuations de la température dans le temps, en valeur relative pour chacune des deux années choisies comme exemples.

Par ailleurs, en valeur absolue, elles se distinguent l'une de l'autre proportionnellement aux différences de température enregistrées au cours de ces deux printemps. Naturellement l'infestation de la parcelle par les adultes de première génération varie dans le même rapport.

Enfin, en raison du facteur physiologique qui incite les imagos de première génération à entrer en diapause, en raison également des conditions de végétation de la Pomme de terre qui ne permettent pas d'offrir à ces insectes un aliment de qualité (Grisson 1947), la deuxième génération est souvent réduite dans les contrées septentrionales de l'Europe et, quand elle a lieu, est issue d'une fraction seulement des adultes apparus en juillet.

A cause de ce caractère d'enfouissement précoce et du fait de la nécessité physiologique pour ces adultes de s'alimenter abondamment, les traitements antidoryphoriques estivaux dirigés contre les imagos de première génération dès leur apparition auront une grande efficacité et une grande importance pratique si l'on veut limiter l'année suivante une infestation dangereuse par elle-même et par sa descendance larvaire.

#### IV. Résumé

1°. La sortie printanière des Doryphores adultes est conditionnée en premier lieu par la cessation de la diapause qui se produit généralement en cours d'hiver par un réchauffement du sol à  $+10^{\circ}\text{C}$  environ;

2°. les déplacements de ces adultes peuvent être considérables, soit par marche, soit par vol, lorsque la température atmosphérique s'élève brusquement, surtout avant les orages; leur activité cinesthésique est proportionnelle à la température;

3°. leur consommation individuelle n'est pas proportionnelle à la température : elle est maximum à  $+25^{\circ}\text{C}$  considérée comme température optimum; elle est nulle en dessous de l'optimum entre  $+10^{\circ}$  et  $+13^{\circ}\text{C}$  et elle ne paraît cesser qu'à la température mortelle au-dessus du seuil;

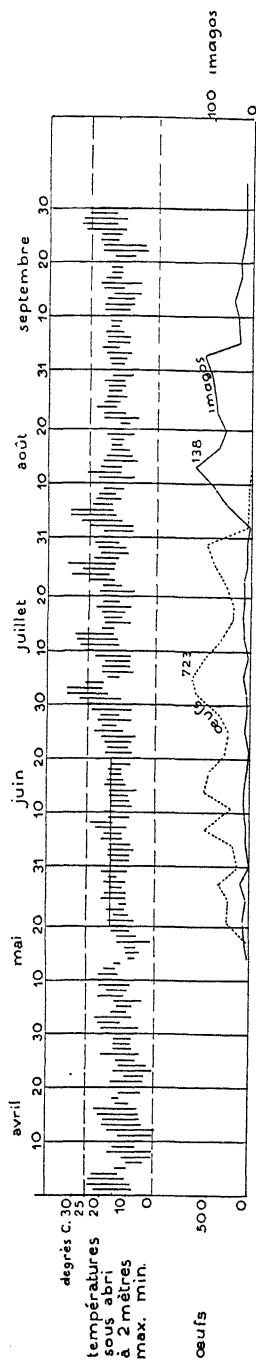
4°. le débit moyen des oeufs par femelle est à peu près proportionnel à la température jusqu'à  $+30^{\circ}$  ou  $+35^{\circ}\text{C}$ ; toutefois, comme la longévité décroît rapidement au-dessus de la température optimum, la ponte totale par femelle est maximum à  $+25^{\circ}\text{C}$ ; les seuils thermiques de ponte correspondent approximativement aux seuils d'alimentation;

5°. les Imagos des générations successives ne réagissent pas d'une manière semblable à la température : dans les meilleures conditions, une fraction de chaque descendance subit immédiatement un arrêt d'activité et entre en diapause sans avoir pondu;

6°. le nombre des générations est donc limité, surtout dans les contrées septentrionales, et chacune d'elles est, ou réduite ou partielle;



## ACTIVITE DU DORYPHORE A VERSAILLES EN 1946



## ACTIVITE DU DORYPHORE A VERSAILLES EN 1947

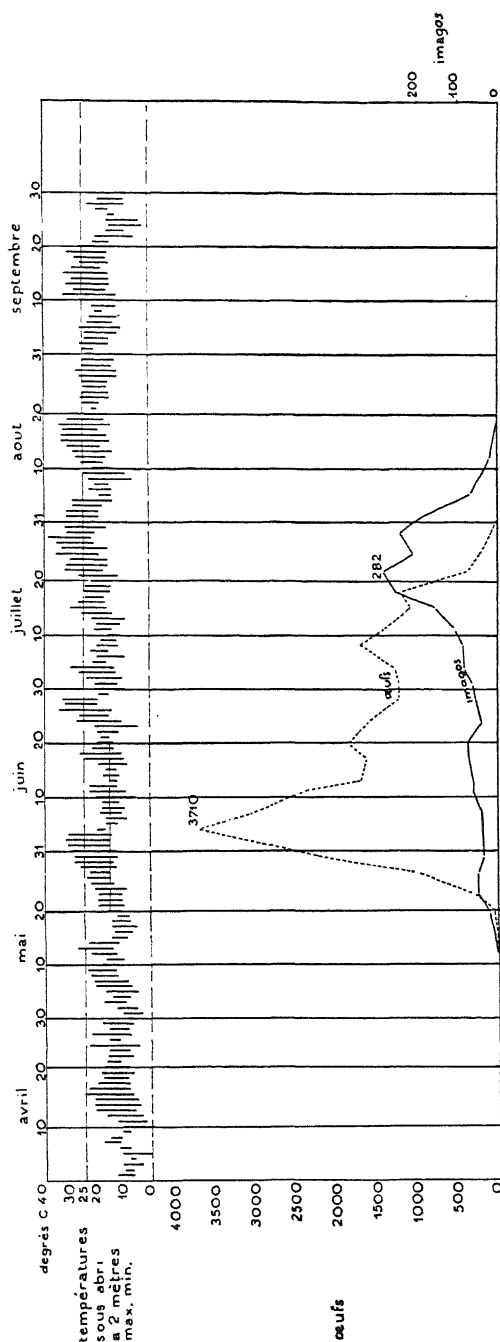


Fig. 7. Extraits de graphiques écologiques établissant le développement du Doryphore chaque année sur des parcelles de Pommes de terre. Comparer notamment entre le 20 mai et le 20 juin 1946 et 1947 les courbes des pontes par rapport à la température de  $+15^{\circ}\text{C}$ .

7°. la première génération est la plus néfaste et souvent la seule existant; la prolifération des imagos qui en proviennent est liée aux caractères climatiques, notamment à la température des mois de mai et juin suivant les règles exposées ci-dessus; les traitements antidoryphoriques doivent être appliqués méthodiquement contre les imagos de première génération avant qu'ils ne s'enfouissent pour la diapause et l'hibernation.

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## AN APPARENTLY UNRECORDED MODE OF REPRODUCTION IN APHIDIDAE

By *D. Hille Ris Lambers*

In the true Aphididae<sup>1</sup> two modes of reproduction occur in almost all the species, when they live in a temperate climate.

In that case oviparous females after mating lay normal, fertilized eggs which after a long period, including winter, hatch. From the eggs develops a viviparous female, never a male. Its vivipary consists in the laying of eggs which are fully developed embryos in a sac, and which normally hatch during the process of laying.

Intermediate forms of laying have as far as I know not been described. One might expect a case in which eggs are laid which hatch soon after being laid. It was quite a surprise when seven years ago I saw this happen, and further studies in this field showed, that many aphids at one time in their cycle reproduce in this way.

If one examines a full grown spring-migrant from one of the gall-making Eriosomatids from *Ulmus* or Pemphigids from *Populus*, it is striking, how all the embryos show the same degree of development.

If such migrants are placed on suitable plants, they start laying eggs at great speed. They do it by curving their abdomen downwards. The egg on appearing touches the substratum with one pole, after which the abdomen is lifted so, that the eggs stands vertically on the substratum, like an egg of a Coccinellid. After this the female moves a little forwards and after a few minutes lays another egg, and so on. The result is a neat row of 4—12 upright eggs. After a short time the first laid egg shows movements. It is rather unusual for a whole egg to move, but in this case the explanation is, that the eggs is nothing but a larva ready for hatching in a sac, as in normal viviparous reproduction. 15—60 minutes after being laid the eggs hatch and the larva goes for food.

This phenomenon was observed regularly in spring migrants of:

*Eriosoma ulmi* L. on *Ribes rubrum*.

*Tetraneura gallarum* Gmelin on *Poa annua*.

*Colopha compressa* Koch on *Poa annua* and *Carex riparia*.

*Pemphigus protospirae* Lichtenstein on *Daucus carota*.

It will undoubtedly be found in the whole group of the Eriosomatids, which all show spring-migrants with embryos of the same degree of development.

The position of the described eggs is rather unusual, for normally in Aphididae both hibernating eggs, and eggs which hatch during laying (vivipary) are laid parallel to the substratum.

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<sup>1</sup> This excludes the Adelgidae and Phylloxeridae.

## SUR QUELQUES FACTEURS QUI CONDITIONNENT LA VARIABILITÉ DE LA TAILLE CHEZ *TENEBRIO MOLITOR* L.

Par Jean Leclercq

Comme la plupart des animaux qui ont accompagné l'homme dans son établissement sur tous les continents, le *Tenebrio molitor* est une espèce extrêmement variable, tant par ses caractères bionomiques (Arendsen Hein, 1929, 1923; Cotton et St. Georges, 1929) que pigmentaires (Ferwerda, 1928) et morphologiques (Bayford, 1948). Si l'on examine une série d'adultes de ce coléoptère, on ne manquera pas de noter la grande variabilité de la taille, certains spécimens se présentant comme deux ou trois fois plus gros que d'autres.

Nous avons entrepris un certain nombre d'élevages de vers de farine afin d'analyser cette variabilité du caractère taille et de rechercher les facteurs qui peuvent rendre compte des différences observées. Le détail de nos protocoles d'expériences sera publié ultérieurement dans "*Physiologia Comparata et Oecologia*", nous nous proposons de résumer ici quelques-uns de nos principaux résultats.

1. *Variabilité des poids atteints par les individus d'une population s'étant développée aux dépens d'une même colonie initiale, entre 25 et 28° C.; la densité de population, le degré hygrométrique et les conditions alimentaires n'étant pas contrôlés.*

Nous avons pesé un total de 1.145 nymphes récoltées dans les élevages le jour de leur formation. Il est apparu que :

a) les nymphes mâles pèsent en moyenne 167 milligrammes, mais on rencontre des spécimens présentant tous les poids compris entre 60 et 290 milligrammes.

b) les nymphes femelles pèsent en moyenne 159 milligrammes, mais on rencontre des spécimens présentant tous les poids compris entre 90 et 250 milligrammes.

c) les poids obtenus dans les deux cas ne se distribuent pas suivant une courbe de Gauss typique car si ce sont les dizaines les plus proches de la moyenne arithmétique qui sont dotées des fréquences les plus élevées, la dizaine qui comprend la moyenne ne se caractérise pas, et loin s'en faut, par une fréquence supérieure à celle des 4 ou 5 dizaines voisines.

De nombreux contrôles ont permis de confirmer qu'il est effectivement de règle générale que les nymphes, et par conséquent les adultes, de sexe mâle pèsent en moyenne quelques milligrammes en plus que les femelles. De même les spécimens mâles peuvent atteindre de façon très générale, des poids qui s'écartent des moyennes nettement plus que ceux des femelles, le caractère taille apparaissant donc comme statistiquement plus variable chez le mâle que chez la femelle.

### 2. *Rythmes ?*

Il n'a pas été possible de déceler la moindre relation entre le poids des nymphes et la saison pendant laquelle se sont effectuées les pontes ou les croissances larvaires. Cependant, dans une même colonie élevée en conditions stables, les nymphes qui sont formées les premières pèsent en moyenne quelques milligrammes en moins que celles qui apparaissent dans la suite.

### 3. Degré hygrométrique

Plus le milieu d'élevage est humide et plus gros sont les spécimens qui y grandissent. Ce phénomène, général chez les insectes inféodés aux denrées alimentaires sèches, s'explique par le fait que les larves maintenues dans une atmosphère sèche utilisent la plus grande partie de la nourriture ingérée pour produire un surplus d'eau métabolique palliant à la déshydratation des tissus (cf. Leclercq, 1948).

### 4. Conditions de nutrition

C'est en élevant les larves de *Tenebrio* dans de la farine non blutée, additionnée de levure de brasserie sèche, que nous avons obtenu les plus gros spécimens. Il n'est pas rare, dans ces conditions, que la majorité des nymphes récoltées pèsent plus de 200 milligrammes, si l'élevage a été réalisé dans l'air modérément humide, sans surpeuplement. En supprimant la levure, ou en blutant la farine, on diminue sensiblement le poids moyen des nymphes. Il convient cependant de remarquer ici que le déplacement des moyennes vers des poids plus élevés n'est pas ou guère accompagné d'une réduction de la variabilité des poids : on obtient encore un certain nombre de nymphes de poids faibles, de l'ordre de 100 milligrammes et le caractère hétérogène des courbes de distribution des valeurs individuelles se maintient en dépit de l'homogénéité et de la richesse nutritive du substrat.

Par contre, en nourrissant les vers de farine avec des cadavres d'insectes moulus et séchés, qu'il s'agisse de *cannibalisme* ou d'*entomophagie*, on déplace toutes les valeurs individuelles et par conséquent la moyenne vers les poids moindres, inférieurs à 150 milligrammes et les résultats ainsi obtenus se distribuent en suivant une courbe de Gauss tout à fait typique. Ajoutons qu'aux milieux nutritifs ainsi conçus il faut obligatoirement ajouter de l'amidon ou du glucose, le *Tenebrio molitor* ne pouvant à la différence des *Tribolium*, effectuer sa croissance aux dépens des poudres d'insectes lesquelles sont carencées en glucides (cf. Leclercq, 1948).

### 3. Densité de population

Le surpeuplement a pour résultat normal de diminuer sensiblement la proportion des nymphes pesant plus de 200 milligrammes. C'est en élevant les larves isolément, avec de la farine en abondance, que l'on obtient les nymphes les plus grosses. Dans les élevages modérément peuplés on obtient des nymphes de poids fort variables, à l'exclusion des poids très élevés dépassant 220 milligrammes. Dans les élevages surpeuplés on obtient exclusivement ou presque des nymphes de moins de 150 milligrammes.

En fait, l'influence de la densité des populations est la résultante de deux incidences distinctes, de nature alimentaire. D'une part la diminution de la nourriture disponible et l'appauvrissement des farines tend à faire apparaître des nymphes de poids réduit, sans empêcher toutefois que certains individus n'atteignent des poids relativement élevés. D'autre part, la pratique du cannibalisme d'autant plus généralisée que les colonies sont plus denses, tend à faire apparaître des nymphes de poids systématiquement inférieurs, ainsi qu'il a été dit précédemment. C'est pourquoi les élevages surpeuplés où une proportion restreinte d'individus arrive aux métamorphoses, après avoir dévoré leurs congénères, sont précisément ceux qui fournissent les courbes de distribution des poids les plus homogènes.

#### 4. Races physiologiques chez *Tenebrio molitor*

Nous avons constaté qu'il est impossible d'obtenir une courbe de G a u s s typique lorsqu'on réunit les poids individuels présentés par un grand nombre de nymphes issues d'un élevage réalisé à température et degré hygrométrique constants, dans de la farine homogène, additionnée ou non de levure. La question se posait donc de savoir s'il n'existe pas au sein des colonies courantes de cette espèce, des races physiologiques du type de celles découvertes par Birch (1944) chez *Calandra oryzae* L. et par Richards (1948) chez *Calandra granaria* L.

Des essais de sélection ont été entrepris en vue de répondre à cette question. Dans une première série d'essais, nous avons éliminé d'une colonie toutes les nymphes pesant plus de 150 milligrammes et nous avons permis aux autres de donner leurs adultes et de se reproduire dans de la farine additionnée de levure. La progéniture de ces nymphes de poids médiocre a fourni une première série de nymphes de poids aussi variables que ceux des élevages non sélectionnés. La même opération sélective a été répétée avec ces nymphes, ce qui a permis d'obtenir une deuxième génération dont les poids étaient compris entre 80 et 210 milligrammes, avec comme moyenne 133 milligrammes, la distribution étant ici non seulement déplacée vers les poids inférieurs mais encore plus rapprochée de la courbe théorique de G a u s s. Enfin une troisième et une quatrième génération ont permis de tracer des diagrammes plus satisfaisants encore, les poids s'y échelonnant entre 70 ou 80 milligrammes jusqu'à 190, avec comme moyennes 135 et 128 milligrammes, et des distributions s'apparentant de façon très satisfaisante avec la courbe de G a u s s. Il existe donc, dans les colonies courantes de *Tenebrio molitor*, un premier type génétique caractérisé par la tendance à fournir des nymphes dont le poids moyen est compris entre 125 et 135 milligrammes. Il n'a pas été possible jusqu'ici de diminuer cette valeur des poids moyens, car les nymphes qui présentent des poids inférieurs à 130 milligrammes ont conduit, après deux générations consécutives, à des nymphes donnant le même diagramme de distribution des poids, avec les mêmes poids moyens (entre 125 et 135 milligrammes).

Nous avons en outre suivi trois générations consécutives dont toutes les nymphes pesant moins de 180 milligrammes ont été éliminées. Il est apparu dans ces conditions qu'il existe un second type génétique caractérisé par des poids moyens nettement plus élevés, voisins de 170 milligrammes, le diagramme de distribution tendant à exclure les poids inférieurs à 130 milligrammes et se rapprochant lui aussi de la courbe théorique de G a u s s.

Si l'on excepte la taille, aucune différence morphologique ou pigmentaire n'a pu être observée en comparant des séries d'adultes appartenant aux deux races ainsi séparées.

#### Résumé

Ce travail démontre que le poids frais des nymphes est un caractère très variable dans les populations courantes de *Tenebrio molitor*. En analysant statistiquement cette variabilité et en réalisant des élevages en diverses conditions écologiques, il a pu être prouvé que : 1°) les nymphes mâles pèsent en moyenne quelques milligrammes en plus que les femelles; 2°) le poids des nymphes est influencé par les conditions d'humidité, la nature de la nourriture, l'abondance de la nourriture, la pratique du cannibalisme et la densité des populations; 3°) il existe chez *Tenebrio molitor* deux types génétiques au moins, l'un correspond à une race qui entreprend ses métamorphoses lorsque ses larves ont atteint des poids relativement faibles, l'autre correspond à une

race qui fournit des nymphes et des adultes plus lourds et de taille plus grande; 4<sup>o</sup>) par suite d'un mécanisme non encore étudié, les individus des deux races produisent tous des nymphes de poids réduits lorsqu'on les nourrit de poudres d'insectes.

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## ÜBER DIE FÄRBUNGSWANDLUNGEN, GENERATIONS- UND FORTPFLANZUNGSVERHÄLTNISSE DER MITTELEUROPÄISCHEN EURYDREMA-ARTEN (II. Beitrag)

Von O. Michalk

### Vorbemerkungen

Im ersten Beitrag zum Thema (Michalk 8) wurden die Färbungsverhältnisse und ihr Zusammenhang mit der Fortpflanzung für *Eurydema ornatum* L. (= *festiva* L. auct.) und *E. oleraceum* L. in den wesentlichsten Zügen bereits geklärt. Es blieben nur noch einige Lücken unseres Wissens, über die s. Zt. Vermutungen ausgesprochen wurden. Verfasser stellte (l.c. p. 1274) in Aussicht, in einer späteren Arbeit auf die Fragen des Ursachen-Komplexes einzugehen. Die hierzu nötigen Untersuchungen wurden 1939 begonnen und mit, durch die Kriegswirren bedingten, Unterbrechungen fortgesetzt. Die Unterlagen sind dann aber leider vernichtet worden<sup>1</sup>. Der vorliegende Beitrag wird deshalb den Fragen nach den Ursachen der Wandlungen noch nicht nachgehen, sondern die oben erwähnten Lücken unseres Wissens z. T. ausfüllen und sich hieraus notwendig ergebende Betrachtungen bringen. Die letzteren sind insbesondere deshalb erforderlich, weil es dem Verfasser 1939 nicht möglich war, die Arbeit von Rusanow (10) zu berücksichtigen. Ferner aber besonders weil die Ausführungen Rusanow's in einer späteren Veröffentlichung (4) falsch wiedergegeben und ihre Anschauungen als abschliessend hingestellt worden sind.

### Terminologie

Es erscheint zweckmässig, einige 1939 bereits gebrauchte Fachausdrücke noch einmal besonders zu erläutern:

„Grundfarbe“ und „Zeichnungen“:

1939 (l.c. p. 1254—1255) war bereits darauf hingewiesen worden, dass aus entwicklungsgeschichtlich-logischen Gründen bei allen *Eurydema*-Arten als Grundfarbe die hellen, (weissen, gelben, orangefarbenen oder roten) Regionen — als Zeichnungen die dunklen (metallisch-grünen, blauen, bronzefarbenen oder schwarzen) Regionen der Ober- und Unterseite zu gelten haben. Auch dann also, wenn die dunklen Regionen in ihrer Ausdehnung gegenüber den hellen wesentlich überwiegen (z. B. bei *E. oleraceum* L. und *E. Fieberi* Fieb.) bezeichnen wir sie deshalb und entgegen der sonstigen Übung als „Zeichnungen“. Von *E. ornatum* L. ausgehend waren 1939 die Bezeichnungen

„*pictum*-Stadium“ = Grundfarbe weiss, gelb oder orange.

„*ornatum*-Stadium“ = Grundfarbe rot und

„*decoratum*-Stadium“ = Grundfarbe rot, Ventrum mit keilförmigen Fleck (bei *ornatum* L. und *E. ventrale* Kol.) oder ganz schwarz (bei *E. oleraceum* L.)

geschaffen und gebraucht worden. Im gleichen Sinne sind diese Bezeichnungen auch hier wieder zu verstehen, es erscheint aber jetzt zweckmässig, die aus den folgenden Bemerkungen hervorgehenden Konsequenzen zu ziehen.

Status (= stat.)

<sup>1</sup> Verfasser wurde am 20. 2. 1944 total ausgebombt, wobei seine Sammlungen, das schriftliche Material, die Literatur verloren gingen.



Bereits 1939 (l.c.) war auf p. 1271 darauf hingewiesen worden, dass sich „gewisse Kalamitäten in systematischer Hinsicht ergeben“, wenn man Namen auf Merkmale gründet, die sich an einem bestimmten Individuum während seines Daseins ändern! Damit sei, wurde an der angegebenen Stelle weiter ausgeführt:

„ein Grundprinzip der nomenklatorischen Behandlung einer Art oder Form verletzt, dass nämlich das Merkmal, auf welches die Form und ihr Name begründet sind, mindestens am selben Individuum unverändert bestehen bleiben müsse.“

Diesem Erfordernis wird in der vorliegenden Arbeit Rechnung getragen. Die genannten Erscheinungsformen werden nicht mehr als „f.“ *pictum* usw., sondern als „stat. *pictum*, stat. *ornatum* usw. bezeichnet. Entsprechend wird bei *E. oleraceum* L., bei welcher Art viel mehr solcher Status in Betracht kommen, verfahren. Andererseits werden Färbungsformen, die auf ein unveränderliches Zeichnungsmerkmal gegründet sind, als Aberration = „ab“ bezeichnet. Als Beispiel für den letzteren Fall kann die ab. *simplicissima* Rey von *E. ornatum* L. gelten, weil ihr Merkmal (Fehlen der vier hinteren, schwarzen Makeln auf dem Pronotum) während des Daseins des Individuums unverändert fortbestehen bleibt. Als Beispiel für den ersteren Fall sei stat. *pictum* genannt, bei dem das entscheidende Merkmal „Farbe gelblichweiss oder weiss“ (der Grundfarbe!) ein vorübergehendes ist, wie bereits 1939 gezeigt wurde.

#### Aberration, Varietät.

Es ist in der entomologischen Literatur weit überwiegend üblich, abweichende Formen als Aberrationen = ab. oder Varietäten = var. zu bezeichnen. Hieran hielten sich bisher fast alle Heteropteren-Autoren. Hier verwenden wir deshalb:

- ab. für individuelle Abweichungen.
- var. wenn es sich um lokal gehäufte Vorkommen bestimmter Abweichungen (Lokalrassen) handelt,
- f. zur Bezeichnung der bei den Heteropteren häufig auftretenden brachypteren (mikropteren) oder (bei sonst mikropteren Arten), macropteren Formen.

#### Färbungswandlung und Generationen im Jahresverlauf

1939 wurde die Frage nach der Anzahl der Generationen der behandelten Arten nur insoweit behandelt, als sie mit der Aufgabe der Arbeit in Zusammenhang stand. Diese Aufgabe aber war, zu klären, ob *E. decoratum* H. S., wie es bis dahin immer wieder behauptet wurde, gegenüber *E. ornatum* L. als besondere Art anzusehen sei. Die angestellten Untersuchungen führten dann zur Entdeckung der Färbungs-Wandlungen. Nachdem bereits damals bei den durchgeführten Zuchten eine zweite Generation für *E. ornatum* L. festgestellt (l.c. p. 1247) und für *E. oleraceum* L. (l.c. p. 1261) als möglich gefolgert war, diese zweiten Generationen aber als abnorme bezeichnet wurden, richtete Verf. sein Augenmerk bei den späteren Untersuchungen besonders auf diese Frage. Des weiteren blieben 1939 auch noch einige Unklarheiten über den Färbungs-Wandlungsverlauf, die zu klären waren. Weil Wandlungen und Fortpflanzung eng zusammenhängen, werden beide auch zusammen behandelt.

Betrachten wir nun die einzelnen Arten.

#### *E. ornatum* L.

1938 (8) stand bereits fest, dass der stat. *pictum* eine frühe Färbungsform also, fortpflanzungsfähig ist. Es mag hier notiert werden, was mein Tagebuch noch darüber enthält:

„15. 8. 1939: Von den am 13. 8. 1939 am Wege nach Fiajano (auf der Insel Ischia im Golf von Neapel) mit dem Streifsack erbeuteten, zahlreichen *E. ornatum* L. im weissen stat. *pictum*, hatte ich heute Morgen vor der Exkursion ein noch ganz rein weisses ♂♀ isoliert untergebracht. Als ich 18 Uhr heimkam, sah ich das ♀ gerade mit der Einablage beschäftigt. 10 Eier waren bereits abgelegt, zwei weitere folgten innerhalb 5 Minuten.“

Und dann:

„23. 8. 1939: Im Laufe der folgenden Tage (vom 15. 8. an) sind noch insgesamt 3 weitere Gelege von den anderen des *pictum*-Stadiums abgelegt worden. Das Gelege vom 15. 8. ist geschlüpft.“

Aus den eben genannten Eiablagen züchtete ich dann, z. T. noch auf Ischia, z. T. nach der Rückreise in Deutschland eine Anzahl Imagines. Die Eier stammten aus dem letzten Drittel des Monats August. Bei den Eltern kann es sich also nicht mehr um eine erste Generation gehandelt haben, denn ich notierte an einer anderen Stelle meiner Tagebücher unter dm 8. 5. 35, dass ich an diesem Tage bei Forio (ebenfalls auf Ischia) den stat. *decoratum*, also überwinterte Tiere in Kopula fand. Dem möglichen Einwand, es habe sich in den berichteten Fällen um südliche Populationen gehandelt, kann begegnet werden. Bereits 1939 (l.c. p. 1247) war berichtet worden, dass aus Eiern Bellinchener Tiere (Bellinchen liegt 75 km nordöstlich von Berlin), die am 15. 9. 1934 abgelegt waren, vom stat. *ornatum* zwei Imagines gezüchtet wurden. Seit 1939 sind nun noch zahlreiche Freilandbeobachtungen<sup>2</sup> angestellt worden. Sie bestätigen durchweg eine zweite Generation. Dies steht aber nun im Widerspruch zu der Ansicht, welche Rusanova (10) pag. 379 aussprach: „Folglich haben die Eurydema im Laufe des Sommers nur eine Generation.“ Wir müssen bei der Besprechung von *E. ventrale* hierauf noch einmal zurückkommen, weil die Verfasserin die Arten *E. ornatum* und *E. ventrale* zusammen behandelt. Dabei werden wir feststellen, dass sie, ohne sich dessen aber bewusst zu werden, selbst zwei Generationen zugibt.

Fassen wir nun zusammen, was z. Zt. über *E. ornatum* L. bekannt ist:

#### 1. Zur Färbung:

Dem, was 1939 (l.c. u.a. auf Tafel 144) über die Wandlungen als bekannt ausgeführt wurde, ist auch nach den seitdem angestellten Nachprüfungen nichts hinzuzufügen. Insbesondere bleibt es bezüglich des weissen stat. *pictum* (f. *chlorotica* Horv.) so, dass er nur in südlichen Populationen auftritt und als Vikariante zum nördlichen orangefarbenem stat. *pictum* anzusehen ist.

#### 2. Generationen.

Die l.c. pag. 1247 ausgesprochene Ansicht „... die Regel ist aber eine Generation im Jahr ...“ lässt sich nicht mehr halten. Vielmehr muss sie dahin korrigiert werden, dass unter normalen Verhältnissen in der Regel eine zweite Generation im Jahre erscheint.

<sup>2</sup> Bei den erwähnten Freilandbeobachtungen muss man sich der weitgehenden zeitlichen Überschneidungen der einzelnen Generationen bewusst bleiben. Zum Glück sind wenigstens die Angehörigen der überwinterten Generation von denen der späteren Generationen einwandfrei dadurch zu unterscheiden, dass sie unterseits den schwarzen Keilfleck haben. Wie weit die zeitliche Überschneidung gehen kann, mag daraus erhellen, dass überwinterte Einzeltiere noch bis Ende Juli (bei *E. oleraceum* notierte ich sogar den 13. August!) leben können. Das gleichzeitige Vorkommen und Zusammenleben der Nachkommen verschiedener Generationen hat auch ihre weitgehende Vermischung zur Folge, denn es können die Angehörigen verschiedener Generationen miteinander kopulieren.

Ja, man muss nun, nachdem wir wissen, dass Eiablagen und Larven frühestens von Anfang bzw. Mitte Mai, andererseits aber bis mindestens Mitte September (der oben aus Bellinchen a. d. Oder berichtete Fall) bzw. in den Oktober hinein im Freiland zu finden sind, sogar noch eine partielle dritte Generation für möglich halten. Dabei wird man diese dritte Generation für die Populationen für südlichere Breiten für wahrscheinlicher annehmen müssen, als für die in nördlicheren. Für viele Tiere, besonders auch Insekten ist ja festgestellt, dass der Entwicklungsverlauf bei höheren Temperaturen verkürzt, bei tieferen verlängert wird.

*E. ventrale* Kol. (*ornatum* L. auct.)

Über diese Art und ihre Wandlungen konnten 1939 (l.c. pp. 1269—1270) nur Vermutungen ausgesprochen werden. Jetzt wissen wir auch von ihr mehr. Ich konnte sie 1944 ab ovo züchten<sup>3</sup>.

Interessant ist, was Rusanova (l.c.) über sie inbezug auf die Färbungswandlungen und die Anzahl der Generationsverhältnisse sagt. Sie führt hierzu p. 379 aus: „Da das Eierlegen bei *E. ornata* (sie sagt *ornata* L. meint aber *ventrale* Kol.) portionsweise geschieht und über längere Zeit ausgedehnt ist, so kommt es vor, dass die Nachkommen eines bestimmten Weibchens in der ersten Hälfte des Juli aus Larven des ersten Stadiums und aus Imagines besteht. Wahrscheinlich gab das Sacharow (11) den Anlass, zu sagen, dass *ornata* im Laufe des Sommers mehrere Generationen hat. Dieselbe Ansicht vertritt auch Schreiner (12) inbezug auf *festiva* L. (= *ornata* L. auct., v. Verf. eingeschaltet) v. *chlorotica* Horv. Aber unsere Beobachtung zeigt, dass die Imagines von *ornata* und *festiva* im ersten Sommer nicht zur Paarung schreiten, sondern in ihrem juvenilen Zustand bis zum nächsten Frühjahr bleiben. Folglich haben die *Eurydema* nur eine Generation.“

Das ist bemerkenswert, wie wir weiter unten noch sehen werden. Seite 380 führt sie weiter aus:

„Zur gleichen Zeit überzeugten wir uns durch unsere Beobachtungen, dass die Imagines von *ornata* sehr interessante Veränderungen in der Färbung in der Zeit von der Imaginalhäutung bis zur Paarung durchmachen . . . Die eben beschriebenen Änderungen der Färbung des Wanzenkörpers brachten mich auf den Gedanken, dass die Färbung, welche wir bei gepaarten Tieren beobachteten, als Paarungsfarbe anzusehen ist und dass sich die Tiere durch die Altersveränderungen auf die Paarungsfarbe vorbereiten. Auf Grund unserer Beobachtungen von 1924 kam ich zu dieser Folgerung. Von dem Vorhandensein einiger Varietäten von *ornata* war uns damals, mit Ausnahme der var. *dissimilis* F. deren fehlerhafte Beschreibung in der oben erwähnten Arbeit von Sacharow enthalten ist, nichts bekannt. . . . Wir kamen auf den Gedanken, dass *dissimilis* tatsächlich nicht existiert (sie meint als selbständige Variante von *ornatum* Aut.) und dass eine Altersabart (sie meint ein Färbungsstadium Aut.) als solche angenommen wird. (Weil sie nämlich die Kopulation von *dissimilis* beobachtet hatte. Aut.).“

Die Verfasserin befand sich also ersichtlich in einem Dilemma. Sie hatte zwar die Kopula von *dissimilis* beobachtet, aber auch, dass *dissimilis* ein vorübergehendes Färbungsstadium ist, sie war andererseits aber auch der Meinung, dass sich nur Tiere mit der „Paarungsfarbe“ also die mit dem grossen geschlossenen, schwarzen Keilfleck auf dem Ventrum, d. i. nach unserer Terminologie stat. *decoratum*, paaren können.

<sup>3</sup> Herrn Hans Feigl — Wien, von dem ich das lebende Material erhielt, sei auch bei dieser Gelegenheit herzlich gedankt.

Aus diesem Dilemma kommt sie erst ein Jahr später heraus, wenn sie ausführt, dass es ihr erst durch das 1925 erschienene Buch von Bogdanova-Katkowa möglich gewesen sei, sich genauer über das 1924 gesammelte Formenmaterial zu orientieren. Das geht hervor aus den Sätzen:

„Die Tatsache der Kopulation dieser Formen in der Natur, anlässlich deren wir grosse Bedenken hatten, da die von uns erhaltenen Imagines sich auf Grund unserer Erfahrungen in jenem Sommer nicht paarten, bestätigte (vom Verf. gesperrt!) die selbständige Existenz der Variationen von *ornata* (nämlich *dissimilis*, *pectoralis* und *ventralis* Verf.).“

Damit war sie einigermaßen aus ihrem Dilemma heraus. Ganz aber auch noch nicht, wie sich aus der Bemerkung auf p. 380 zeigt.

„Dieser Umstand verringert aber keinesfalls die Bedeutung des anderen von uns beobachteten Faktums, und zwar das Vorhandensein der Altersveränderungen in der Färbung von *ornata*.“

Bezüglich *E. ventrale* haben sich nun aber auch noch eine Reihe anderer Autoren dahin ausgesprochen, dass die Art mehrere Generationen im Jahre hat. Wie wir eben sahen, tat das auch Rusanowa, ohne dass sie sich dessen bewusst wurde. Die erwähnten anderen Autoren sind Bei-Bienko (1), Korol'Kov (7), Servadei (13), Uvarov u. Glazunov (14). Wie schon 1939 (l.c.) vermutet, macht *ventrale* während des individuellen Lebens ebenfalls Wandlungen der Färbung durch. Über sie kann z. Zt. folgendes dargelegt werden.

Die überwinterten Tiere haben, genau wie wir es von *E. ornatum* (= *festivum* auct.) wissen, nach der Überwinterung auf dem Ventrum einen geschlossenen, schwarzen Keilfleck. Dieser ist aber hier seitlich nicht gerade, sondern bogig scharf begrenzt. Die Abkömmlinge der überwinterten Generation, also die Angehörigen der neuen Generation, haben diesen Fleck nach der Imaginalhäutung nicht, er kann aber bei einzelnen Tieren durch kleine schwarze Makeln am Vorderrand jedes Ventralsegments bereits angedeutet sein. Die Grundfarbe ist unter- und oberseits zuerst weiss oder orange, sie wandelt sich allmählich in rot um. Bei den von mir gezüchteten Tieren der ersten Generation nach längstens vier Wochen<sup>4</sup>. Wir haben bei *E. ventrale* also ganz analog wie bei *E. ornatum* einen stat. *pictum* und stat. *ornatum* und nach der Überwinterung den stat. *decoratum*. Der Wandlungsverlauf war aber bei den von mir gezüchteten Tieren der ersten Generation insofern von *E. ornata* abweichend, als sich das ♀ des kopulierten Paares (der von mir gezüchteten neuen, ersten Generation) auf dem Ventrum ausgedehnt in schwarz umfärbte! Jedoch waren die Seitenränder dieser schwarzen Ventralzeichnung nicht, wie es bei den überwinterten Tieren ausnahmslos der Fall ist, scharf begrenzt. Auch machte die schwarze Ventralzeichnung mehr den Eindruck, als ob sie von innen her durchschien. Das aber scheint auch Rusanova zu meinen, wenn sie (l.c., s. weiter oben) von

<sup>4</sup> Ich erhielt die lebenden Tiere im Juni 1944 aus Wien. Sie hatten unterwegs schon Eier abgelegt und legten weitere dann noch bei mir, sodass ich deren 60 Stück hatte. Die ♀♀ starben dann ab, offenbar hatten sie schon vor dem Fang Eiablagen produziert. Aus diesen 60 Eiern erhielt ich 13 Imagines einer ersten Generation. Ein ♀ von ihnen kopulierte mit Unterbrechungen in der Zeit vom 13. bis 30. 8., das ♀ erbrachte 2 Eiablagen von je 12 Stück, aus denen am 31. 8. und 10. 9. die Larven der zweiten Generation schlüpften. Sie starben sämtlich bis 30. 9., nachdem sie bei der damals herrschenden, abnorm kühlen Temperatur oft tagelang untätig an einer Stelle im Zuchtglas gesessen hatten. Auch konnte ich sie infolge der täglichen Fliegeralarme nur mangelhaft betreuen. Das wichtigste Ergebnis der Zucht war aber, dass eine zweite Generation und die Fortpflanzungsfähigkeit von Individuen, die noch nicht die Endfärbung, den stat. *decoratum* erreicht hatten, bewiesen war.

einer „Paarungsfarbe“ sprach, die sie beobachtet habe. Also liegt bei *ventrale* schon bezgl. der Unterseite eine Abweichung im Verlauf der Färbungswandlung gegenüber *E. ornatum* vor.

Es kommt nun aber noch eine andere, wichtige Abweichung in Betracht. Die Färbung der dorsalen Segmente des Abdomens der ♀♀ unterliegt ebenfalls einer Färbungsumwandlung, die bisher nirgends beobachtet worden ist. Folgende: Nach der Imaginalhäutung und Chitinerhärtung sind alle Abdominaltergite in beiden Geschlechtern orange (im stat. *pictum*) bzw. rot (im stat. *ornatum*) gefärbt, nur das letzte Tergum zeigt meist in beiden Geschlechtern in der Mitte einen schwarzen Fleck, von kleinerer oder grösserer Ausdehnung, (Abb. 1 a). Während sich die Grundfarbe nun zum stat. *ornatum* wandelt, entwickelt sich auch eine abdominale schwarze Dorsal-Zeichnung, die auf den distalen Tergiten beginnt und sich in proximaler Richtung fortsetzt, sodass zuletzt nur noch jederseits des Scutellums zwei kleine, rote Grundfarbe-Makeln auf dem zweiten und dritten Tergum übrig bleiben. (Abb. 1 b). Dieser Zustand ist bei allen ♀♀ nach der Überwinterung gegeben. Es liegt also ein entsprechender obligatorischer Wandel der ♀♀ und damit ein sekundäres Geschlechtsmerkmal für sie vor. Dies aber ist nun wieder in systematischer Hinsicht wichtig, wie wir gleich sehen werden.

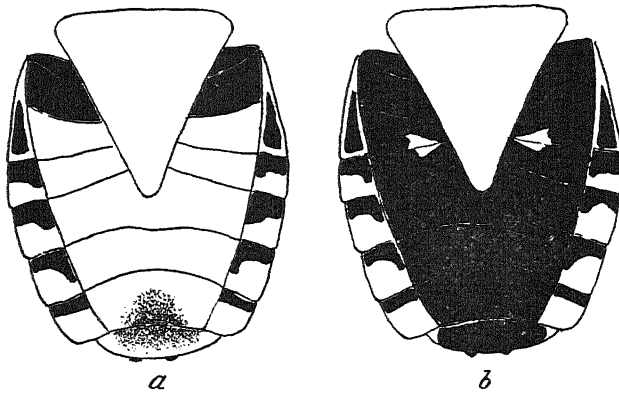


Abb. 1. Dorsale Segmente des Ventrum von *E. ventrale* Kol.

a) vor und

b) nach der Wandlung.

Zur Unterscheidung der *Eurydema*-Arten wurden die Kriterien „Dorsum rot“ und als Gegensatz „Dorsum schwarz“ geschaffen (2). Unter „Dorsum rot“ wurde neben *E. dominulus* Scop. *E. ventrale* Kol. gesetzt. Gulde (5) war der Wirklichkeit näher, wenn er sagte: „Auf dem Rücken wenigstens die vorderen Tergite rot“, was aber, wie oben und aus der Abb. 1 b ersichtlich, insofern auch nicht zutrifft, als auf den vorderen (dem zweiten und dritten unserer Terminologie, s. oben) Tergiten der ♀♀ nur noch ein Restchen der roten Grundfarbe vorhanden ist. Dann ging man 1944 (4) noch weiter.

Es wurde ein Subgenus *Rubrodorsalium* mit *E. ventrale* als Typus generis aufgestellt und auf ein Färbungsmerkmal, nämlich „Dorsum rot“ gegründet<sup>5</sup>.

Der Untergattungsname „*Rubrodorsalium*“ ist also nicht zu halten, weil er für die ♀♀ von *E. ventrale* nur solange zutrifft, als sie sich noch in den stat. *pictum* und *ornatum* befinden.

Fassen wir zusammen, was nun über *E. ventrale* bekannt ist.

### 1. Färbung.

*E. ventrale* unterliegt den schon 1939 vermuteten Färbungswandlungen. Die einzelnen Individuen durchlaufen einen

- |                          |  |
|--------------------------|--|
| stat. <i>pictum</i> ,    | mit <i>weisser</i> oder <i>orange</i> Grundfarbe, Ventrum ohne geschlossenen, seitlich scharf begrenzten, schwarzen Keilfleck,               |
| stat. <i>ornatum</i> ,   | mit <i>roter</i> Grundfarbe, Ventrum zeigt meist schon am Vorder-<br>rand der Abdominalsegmente mehr oder weniger grosse schwarze<br>Flecke, |
| stat. <i>decoratum</i> , | mit <i>roter</i> Grundfarbe, Ventrum mit grossem, schwarzen, seitlich<br>scharf begrenzten Keilfleck.  |

Abweichend vom Wandlungsverlaufe bei *E. ornatum* L. scheint der stat. *decoratum* aber bereits bei den neuen Generationen vor der Überwinterung vorzukommen. Nähere Untersuchungen wären hierzu noch anzustellen.

### 2. Generationen.

*E. ventrale* hat jährlich wenigstens zwei Generationen, eine dritte erscheint, besonders in wärmeren, südlichen Gebieten, möglich.

Allgemein sei bemerkt, dass die russische Autorin *Rusanowa* (10) schon 1924 die uns nun genauer bekannten Färbungswandlungen in Einzelzügen beobachtet hat. Sie hat auch schon eine zweite Generation beobachtet, aber nicht bewusst als solche ansprechen können, weil ihr die nötige Literatur und damit die Möglichkeit fehlte, sich über die einzelnen Färbungsformen von *E. ventrale* klar zu werden. Wenn sich spätere Veröffentlichungen (4) auf sie mit den Worten stützten:

„Erst im Endstadium der Umfärbung, dem Rochzeitskleid, findet eine Vereinigung statt, vorangegangene Farbformen können (vom Verf. gesperrt!) nicht zur Paarung schreiten.“

so sind *Rusanowa*'s Ausführungen falsch verstanden worden.

### *E. oleraceum* L.

Schon aus der nahen Verwandtschaft<sup>6</sup> und aus der Gleichheit der Lebensweise von *E. ornatum*, *ventrale* und *oleraceum* darf man für letztere Art annehmen, dass sie sich bezüglich des Generationswechsels ähnlich verhält, wie die beiden anderen

<sup>5</sup> Eine Untergattung nur auf ein Färbungsmerkmal zu begründen, erscheint an sich schon bedenklich. Hier musste es das aber umso mehr sein, als bereits 1939 (8) Färbungswandlungen auch bei *E. ventrale* wahrscheinlich gemacht waren. In der gleichen Veröffentlichung von 1944 (4) wurde auch noch eine neue Art, *E. mrugowskyi*, aufgestellt und wieder auf ein Färbungsmerkmal, nämlich auf die Anordnung der schwarzen Flecken der einzelnen Segmente des Connexivum gestützt, aber gerade die Flecken auf den Segmenten des Connexivum sind bei den Wanzen ausserordentlich variabel, derart, dass sie entweder mehr oder weniger ausgedehnt, oder gar nicht vorhanden sein können.

<sup>6</sup> Es gelang mir übrigens 1939 *E. ornatum* ♂ mit *oleraceum* ♀ zu kreuzen und 14 hybride Nachkommen zu erzielen, die leider im Bombenkrieg mit untergingen. Diese Kreuzungszuchten werden wiederholt. Es wird später über sie berichtet werden.

Arten. In einer ganzen Reihe nach Erscheinen der Arbeit von 1939 durchgeführten Zuchten konnte eine zweite Generation beobachtet werden. Dass sie auch in der freien Natur vorkommt, mögen die folgenden Ausführungen zeigen. Zunächst sei festgestellt, dass *oleraceum* fast stets mit *ornatum* — in südlichen Gebieten aber auch *ventrale* (s. u. a. Rusanowa l.c. p. 378) — vergesellschaftet auftritt und mit *ornatum* auch die frühesten und spätesten Erscheinungsdaten gemein hat. So gilt für *oleraceum* sinngemäss, was im Abschnitt über *ornatum* ausgeführt wurde. Im Jahre 1944 stellte ich im Freiland noch am 20. August neben gelbfleckigen (s. hierüber weiter unten), frisch entwickelten Imagines grössere Larven-Stadien sowie Nymphen fest. Da andererseits Larven bereits von Mitte Mai ab gefunden werden können, bis 20. August also etwa 3 Monate Zeit liegen, kann schon aus diesen wenigen Daten die zweite Generation gefolgert werden, auch wenn man im Auge behält, dass einzelne, überwinterte Imagines, (d. s. stat. *decoratum*), noch bis Mitte August im Freien angetroffen werden können. Es handelt sich bei diesen Stücken um Nachzügler. S. hierzu auch, was weiter oben in einer Fussnote über die Überschneidungen der einzelnen Generationen gesagt wurde.

Bezgl. des Verlaufs der Färbungswandlung bestanden 1939 noch zwei Unklarheiten.

Über die „gelbfleckigen“ Individuen (wie sie 1939 genannt wurden), entsprechend den einleitenden Ausführungen müssen wir jetzt von gelber Grundfarbe reden!) wurde 1939 ausgeführt:

„Es ist möglich, dass es sich bei den gelb- und orangefarbenen Formen um ein geographisch bedingtes Merkmal handelt, denn ich glaube beobachtet zu haben, dass die orangefleckigen Formen in sog. warmen Gebieten (auf Kalkboden bei Karlstadt a/Main z. B.) vorherrschen.“

Dies konnte nun durch ab ovo-Zuchten und zahlreiche Freilandbeobachtungen aufgeklärt werden.

Die gelbe Grundfarbe ist das erste obligatorische Färbungsstadium nach der Imaginal-Häutung. Es wird von allen Individuen durchlaufen (s. auch Tafel Seite 248).

Es war 1939, (pp. 1264, 1265), ferner über wenige Individuen berichtet worden, deren Grundfarbe schon vor der Überwinterung teilweise rot war. Hierzu ist durch Zuchten und Massenfänge nunmehr festgestellt worden, dass die Wandlung der Grundfarbe in Rot doch häufiger, als damals vermutet, schon vor der Überwinterung einsetzt. In keinem der neuerdings beobachteten Fälle wurde aber das dunkle Rot, das wir nach der Überwinterung beobachten, festgestellt. Es handelte sich im Gegenteil immer um ein sehr helles Rot, welches die vorherige Grundfarbe Weiss auch nur in ganz seltenen Fällen ganz verdrängt. Niemals konnte beobachtet werden, dass der Rot-Färbungsprozess noch bei Tieren mit gelber Grundfarbe begann.

Über *E. oleraceum* L. ist nun soviel bekannt, dass der Versuch unternommen werden konnte, den Lebenszyklus in einem Biogramm — s. Tafel 000, schematisch darzustellen. Aus ihm ist u. a. auch zu ersehen, dass Individuen mit noch gelber Grundfarbe schon kopulieren können. Das wurde zweimal im Freien beobachtet.

Bei der zweiten und eventl. dritten Generation wurde hinter Exitus ein Fragezeichen gesetzt, weil nicht untersucht wurde, ob die kopulierten Individuen u. U. noch bis zum nächsten Frühjahr leben.

Bei der ersten Generation wurde bemerkt, „Ein Teil der ersten Gen.“ (kopuliert und zeugt eine zweite Generation), weil es durchaus möglich erscheint, dass nicht alle Tiere der neuen Generation zu einer Paarung kommen. Dies ist in der freien Natur erklärlicherweise nur sehr schwer festzustellen. Wenn hier und da Einzeltiere der überwinter-





ten Generation bis gegen den September hin vorkommen, offenbar weil sie aus irgendwelchen Gründen nicht zu einer Kopulation kamen, so muss man es auch für möglich halten, dass die erwähnten Angehörigen der ersten Generation ohne kopuliert zu haben, überwintern. Bedacht muss ja auch werden, dass die erste Generation u. U. erst im Juli zur Entwicklung kommt, also von den oben erwähnten Nachzüglern gezeugt wurde.

#### *E. Fieberi Fieb.*

Nachdem mir seit 1939 das Singer'sche<sup>7</sup> Sammlungsmaterial von dieser Art vorlag, kann jetzt mit grösserer Gewissheit vermutet werden, dass *E. Fieberi* ähnlichen Färbungswandlungen unterliegt, wie die eben behandelten Arten.

Dieses Material enthielt Stücke von orange bis roter Grundfarbe, mit Zeichnungen, die von metallisch-grün, über blau-grün bis zu leuchtend kobaltblau, bronzefarben und schwarz variierten. Die erwähnten kobaltblauen Stücke stammten aus dem mittleren Italien.

Da *Fieberi* eine montane Art ist, fast alle mir bekannt gewordenen Funddaten zeigen höhere Lagen, so wäre für sie noch am ehesten möglich, dass sie nur eine Generation im Jahresablauf hat. Doch bedarf dies, wie auch der vermutete Färbungswandel noch der Nachprüfung an lebendem Material. Solches zu erlangen, war mir bisher trotz aller Bemühungen leider nicht möglich.

#### *Wandel der Zeichnungsfärbung.*

Es war schon 1938 (8) ausgesprochen worden, dass sich auch die Zeichnungen, also die dunklen Regionen der Ober- und Unterseite der einzelnen Individuen wandeln. Bei den seitdem angestellten Untersuchungen hat sich das erneut bestätigt. Es kann heute bestimmter, als 1939 folgendes als im allgemeinen geltend ausgesprochen werden. Die Zeichnungsfärbung kann man wie folgt einteilen:

1. Metallisch-grün oder blaugrün.
2. Metallisch-blau, selten leuchtend kobaltblau.
3. Bronzefarbig, d. h. dunkel-metallisch, ohne Einschlag von grünen oder blauen Tönungen.
4. Schwarz, mit kaum wahrnehmbarem, metallischem Glanz bzw. ohne solchen.

Bei *E. ornatum* ist die unter 3. genannte Tönung von mir bisher nicht beobachtet worden, sie kommt aber bei *E. oleraceum* (s. Tafel 000) und bei *E. Fieberi* in gewissen Grundfarbstadien vor.

Nach dem Verhalten der Zeichnungsfärbung ist anzunehmen, dass sie sowohl durch Pigmente (wahrscheinlich Melanine) wie auch durch Strukturen hervorgerufen wird. Die ersteren sind in die Exokutikula eingelagert. Die Metallfarben bzw. der Metallglanz entstehen wohl durch Strukturveränderungen an der Oberfläche der Kutikula, deren Ursachen uns nicht bekannt sind. Sie überlagern die Pigmentfarbe. Beide Farbarten wandeln sich während des individuellen Lebens. Es zeigt sich dabei auch deutlich eine Kausalität zwischen Grundfarbe- und Zeichnungswandel. Im übrigen aber kommen metallisch gefärbte Zeichnungstönungen bei südlichen Tieren häufiger als bei nördlichen vor, sodass man an den Einfluss der intensiveren Besonnung und die allgemein höheren Temperaturen als auslösende Faktoren denken muss.

<sup>7</sup> Dr. Karl Singer — Aschaffenburg, ein ausgezeichnete Kenner der mitteleuropäischen Heteropteren, der die bedeutendste deutsche Privatsammlung der Ordnung hat. Ihm danke ich besonders herzlich für die Überlassung des erwähnten Materials.

So sind wir bezgl. der Zeichnungsfärbung gegenüber dem Stande von 1939 noch nicht viel weiter gekommen. Es muss uns einstweilen genügen, sicherer, als 1939 zu wissen, dass sich auch die Zeichnungsfärbung wandelt.

### *Die Färbung des Kopfes, der Beine und der Brustsegmente*

Es erschien in der vorliegenden Arbeit nicht notwendig, die Färbungswandlungen am Kopf, den Beinen (Tibien bei *E. oleraceum* z. B.) usw. ausführlicher zu behandeln, weil sie einmal schon 1939 erwähnt wurden und andererseits weniger auffällig sind.

Auf eines muss aber kurz eingegangen werden. Auf den einzelnen Brustsegmenten aller behandelten Arten sind im stat. *pictum* hier und da auch noch im eben erreichten stat. *ornatum* sogenannte „Augenflecke“ festzustellen, d. s. inmitten der dunklen Zeichnungen oder ihrer ersten Anlage liegende orange oder rote Flecken bzw. Grundfarbreste. Für die ab. *dissimilis* Fieb. und ab. *Falleni* Gorski von *E. ornatum* sind sie sogar als Form-Merkmal in die Beschreibung mit aufgenommen worden, (s. G u l d e (5) pag. 157).

Auch diese Augenflecke sind *vorübergehende* Färbungsmerkmale. Der stat. *decoratum* zeigt sie bei allen Arten nicht mehr.

### *Zum sog. Massenwechsel*

Alle Eurydema-Arten legen ihre Eier schubweise, jedesmal 12 Stück ab. Zwischen den einzelnen Ablagen (von je 12 Eiern) finden erneute Kopulationen statt. 1939 hatte ich berichtet, dass ich bis zu vier Ablagen von einem ♀ beobachtete. Bei den späteren Zuchten wurden mehrfach bis zu 10 Eiablagen von einem ♀ (bei *E. oleraceum*) festgestellt, d. s. bis zu 120 Eier, die im Verlaufe von vier Wochen produziert wurden. R u s a n o v a (10) berichtete schon 1924 über 8 Eiablagen von je 12 Stück von *E. ventrale*, und zwar von ♀♀ aus dem Freien, die vielleicht schon vor dem Fang Eier abgelegt hatten. Man kann also annehmen, dass ein ♀ unter normalen Verhältnissen ca 100 Eier produziert, also viel mehr, als sonst vielfach angenommen wurde. Da nun auch erwiesen ist, dass wenigstens zwei Generationen im Jahre in Betracht kommen, so lassen sich die gelegentlichen Massenvorkommen der einzelnen Arten nunmehr leichter als bisher erklären.

### *Phylogenetische Betrachtung*

Je mehr man sich in die hier geschilderten Färbungswandlungen und in die Ontogenese der einzelnen Arten vertieft, um so häufiger stösst man auf phylogenetische Fragen. So drängt sich eine Betrachtung der Färbungs-Phylogenese geradezu auf. Sie soll hier versucht werden, weil durch sie u. U. Anhaltspunkte für künftige Artuntersuchungen und für eine möglichst natürliche Systematik nicht nur für die Arten des Genus Eurydema, sondern vielleicht auch für verwandte Gattungen gewinnen lassen. Hierauf wurde schon 1938 (8) hingewiesen.

Die Zeichnungslosigkeit ist als das entwicklungsgeschichtlich Ursprüngliche (bei den Insekten wohl überhaupt) anzusehen. Man kann nun wohl davon ausgehen, dass die Tendenz der Färbungsentwicklung bei Eurydema in der Richtung ihrer Zunahme liegt. Diese Annahme wird gestützt, wenn wir die Ontogenese der einzelnen Arten und die individuelle Färbungswandlung im Auge behalten. Jedes Individuum tritt nach der Imaginalhäutung erst ohne jede Zeichnung ins Dasein. Mit dem Fortschreiten der Erhärtung des Chitin-Skeletts treten Zeichnungen auf. Sie haben nach

der Erhärtung eine bestimmte Ausdehnung und diese nimmt dann noch während des Daseins auf Kosten der Grundfarbe zu.

Dass es sich bei den *Eurydema*-Arten um entwicklungsgeschichtlich junge Arten handelt, scheint schon aus der Homologie ihrer Zeichnungen hervorzugehen. Es lässt sich andererseits aber auch aus der grossen Ähnlichkeit ihrer Lebensweise, z. B. daraus, dass sie durchweg an Cruciferen leben, folgern. Zuletzt liegt aber auch noch für zwei Arten ein experimenteller Beweis durch die weiter oben schon erwähnte Kreuzung von *ornata* ♂  $\times$  *oleraceum* ♀ vor.

Nach der Anlage und Ausdehnung der Zeichnungen, sowohl ober- wie auch unterseits ergibt sich die in Abb. 2 (sie stellt der Einfachheit halber nur die Oberseite dar) gegebene, aufsteigende Folge. Es handelt sich hier um Schemen, welche nur die häufigsten, den Mittelwert darstellenden Erscheinungsformen wiedergeben. Wenn bezüglich der Art mit den am wenigsten ausgedehnten Zeichnungen, Typus *ornatum* der Abbildung 2, eingewendet wird, dass verhältnismässig häufig Aberrationen mit geringerer, nicht selten sogar fehlender Zeichnung auf dem Prototum beobachtet werden, so möchte ich diese Aberrationen als Atavismen ansprechen. Auch kann der hier entwickelte Gedenkengang kaum dadurch gestört werden, dass wir nur 4 von etwa 30 palaearktischen Arten zur Betrachtung heranziehen. Bezüglich ihrer Zeichnungen bewegen sich die übrigen Arten im grossen und ganzen innerhalb des dargestellten Typus *ornatum* und Typus *oleraceum*. Das Zeichnungsgrundschema<sup>9</sup> ist jedenfalls durch die ganze Gattung zu verfolgen. Betrachten wir nun unter den dargelegten Gesichtspunkten zunächst einmal die Zeichnung des Pronotums. (Abb. 3.) Wir sehen beim Typus *ornatum* jederseits drei einzelne Flecken und ihre Tendenz zusammenfliessen, bis dann, bei *oleraceum* und *fieberi* ein Endstadium, jederseits ein schwarzer Fleck, der nur noch schmale Ränder von der Grundfarbe übrig lässt, erreicht wird. Dieser Endtypus wird hier und da natürlich auch schon von einzelnen Individuen von *E. ornatum* und *E. ventrale* erreicht. Diese individuellen Aberrationen eilen der Entwicklung gewissermassen voraus.

Betrachten wir nun das Scutellum und seine Zeichnungen unter Zuhilfenahme der Abb. 4., dann finden wir, das eben für das Pronotum ausgeführte bestätigt. Die Abbildung 4 zeigt einen „Prototypus“. Er soll andeuten, wie der Zeichnungs-Entwicklungsverlauf bis zu dem auf den Abbildungen dargestellten Typus *ornatum* gewesen sein mag. Wir finden die auf dem „Prototypus“ dargestellte Zeichnungsanlage des Kopfes, Pronotums und Scutellums bei zahlreichen Arten der Heteropteren. Erwähnt seien von den Pentatomiden die Gattungen *Carpocoris*, *Eurygaster*, *Sciocoris* usw.; aber auch bei vielen *Coreiden* (*Corizus* u. a.), *Lygaeiden* (*Heterogaster* u. a.), *Nabiiden*, ja selbst bei *Capsiden*. In eben so zahlreichen Fällen lässt sich auch feststellen, dass die Scutellum-Fläche als erste ganz von der Zeichnung, zumeist Schwarz, eingenommen wird. Wo nicht, da bleiben fast immer die Schildspitze und Teile der seitlichen Schildränder noch hell (zahlreiche *Lygaeiden*), also etwas ganz ähnliches, wie wir es beim Typus *ventrale* und Typus *Fieberi* der Abb. 4 darstellten. Nach dieser Umschau in der ganzen Subordnung findet der hypothetische „Prototypus“ eine gewisse Bestätigung. Er zeigt uns nun aber auch 4 dunkle Makel-Anlagen auf dem Pronotum, die sich auf dem Kopf fortsetzen. Sie finden sich bei fast ebenso zahlreichen Arten der Heteropteren, sodass wir den eben für das Scutellum angenommenen phylogenetischen Entwicklungsverlauf auch für das Pronotum annehmen können.

<sup>9</sup> S. hierzu Lengerken (7a), Hans von (Z. angew. Ent. 1930, Vol. 16, p. 206 ff.), der die Zeichnungen der *Eurydema*-Arten ausführlich behandelt.

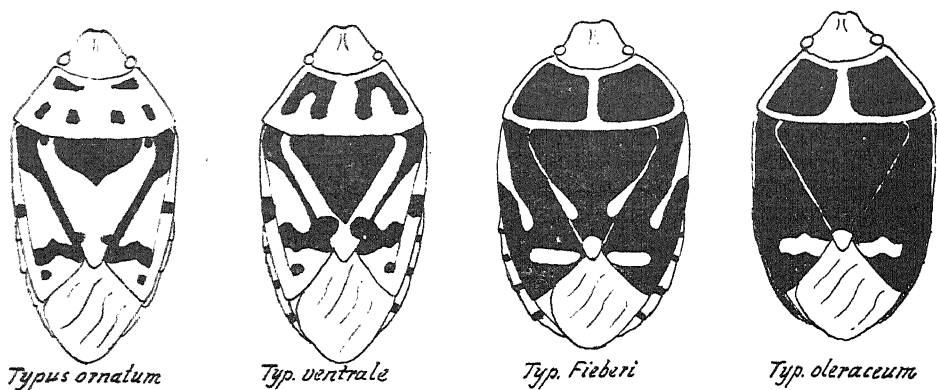


Abb. 2. Schema zur Darstellung der Zeichnungs-Philogeneseis der Eurydema-Arten.

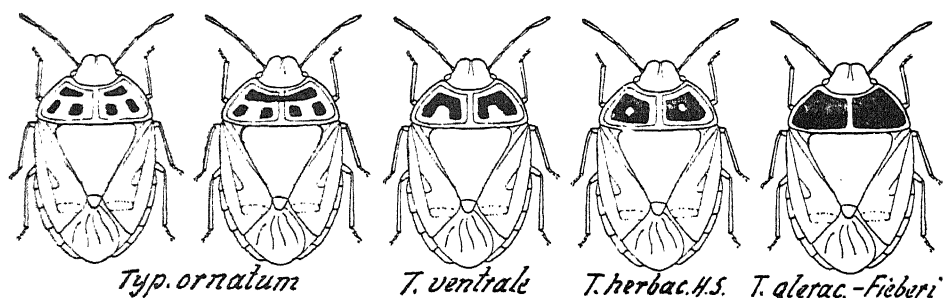


Abb. 3. Philogenetische Zeichnungs-Entwicklung auf dem Pronotum.

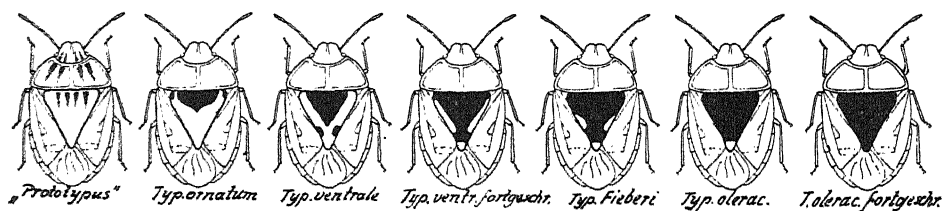


Abb. 4. Philogenetische Zeichnungsentwicklung des Scutellums.

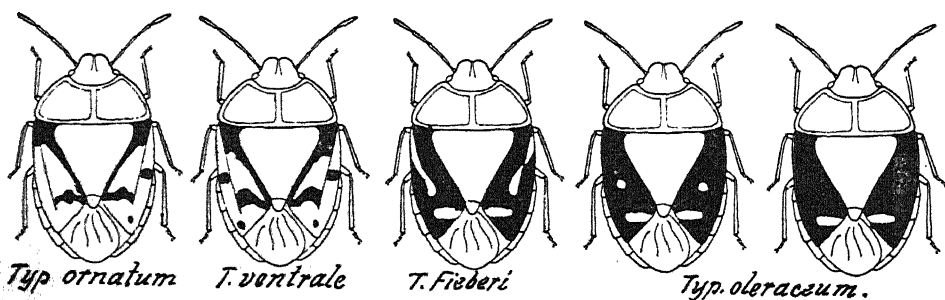


Abb. 5. Philogenetische Entwicklung der Zeichnungen auf den Halbdecken.

Was für Pronotum und Scutellum ausgeführt wurde, gilt sinngemäss auch für die Oberflügelzeichnung. Der gedachte phylogenetische Verlauf wird auf Abb. 5 gezeigt. Als das Ursprüngliche erkennen wir hier die L-förmige Anordnung der Zeichnung auf jeder Decke. Von Art zu Art zunehmend, füllt sich dann der Winkelraum des L aus, bis bei *E. Fieberi* nur noch ein tropfenförmiger Grundfarberaum freibleibt, der dann zuletzt — beim Typus *oleraceum* — auch noch ausgefüllt wird. Bei letztgenannter Art kommen sehr selten aber noch Individuen vor, bei denen ein von der Zeichnung noch freigelassener Grundfarberest etwa in der Mitte der Halbdecken freigelassen ist. Es sind die Formen, die 1939 unter „Mesocorium mit Fleck“ aufgeführt sind. (S. Michalk l.c. Abb. 2 und 3).

Es muss noch auf folgendes hingewiesen werden. Bei sehr vielen Heteropteren in Sonderheit aber auch bei den hier behandelten *Eurydema* liegen auf dem vorderen Teil des Pronotums und des Scutellums deutlich feststellbare Wulste. Diese und die an sie grenzenden Teile des Integumentes sind meist durch andersartige Sculptur ausgezeichnet. Die regelmässige Punktierung ist an diesen Stellen entweder durch deutliche querverlaufende Runzellungen (feine Cuticularfaltungen) ersetzt oder durch sie unterbrochen. Es ist nun auffällig, dass sich die Zeichnungen gerade an den bezeichneten Stellen zuerst, und zwar ontogenetisch und auch in der hier angenommenen Hypothese phylogenetisch zuerst einstellen. Ob sich diese Erscheinung nach Hagen (6) damit erklären lässt, dass es sich hier um Stellen regeren Stoffwechsels (Muskelsätze) handelt, müsste bei näheren Untersuchungen im Auge behalten werden.

Nach der vorliegenden Betrachtung kommt man auf den Gedanken einer *Orthogenesis* der Zunahme der Zeichnungen, deren Ziel die dunkle Einfarbigkeit sein könnte. Bei zahlreichen anderen Heteropteren — allen zeichnungslos dunklen bzw. schwarzen Arten — könnte man dieses „Ziel“ als erreicht ansehen. Von den hier behandelten Arten wären *E. oleraceum* und *E. Fieberi* phylogenetisch am weitesten in der Entwicklung der Färbung fortgeschritten. Wir haben also in der hier dargestellten Ontogenese der *Eurydema*-Arten eine „Rekapitulation“ der Phylogenese der Zeichnungen vor uns.

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## THE STATISTICO-PHYSIOLOGICAL ANALYSIS OF THE VITAL RESISTIBILITIES TO WATER, KEROSENE, AND PYRETHRIN OF THE WORKERS OF *Cremastogaster brunnea matsumurai* FOREL

By Wataru Ohsawa and Sumio Nagasawa

### I. Introduction

It has been pointed out by Henderson-Smith (1923) and Osterhout (1922) that there are two means by which the rate of lethal action of a toxic agent upon organism is expressed: the lethal effect produced in a given time and the time taken to produce a given lethal effect. The former is generally given in terms of mortality, of which the statistical analysis and methods of computation have been fully developed of late years. The latter is usually represented functionally by the average lethal or survival time. Considering that the irreversibility of lethal action requires number of individuals for determining precisely the average lethal time, and that the individual susceptibilities are distributed over such a wide range of time and in such a skewed form that the variation of measurements can not be regarded merely as an experimental error, functional relations in toxicological phenomena such as the relation between time and dosage should be necessarily dealt with statistically. It will be also the case for most of the other physiological phenomena, which have been discussed functionally. For instance, the statistical approach to the thermo-biokinetic theories will acquire new potentialities. The present work has been undertaken as an attempt to introduce the statistico-physiological analysis into the "functional phenomena" in biology.

Ants, which can be gathered in a large number at a time for the greater part of the year, and of which there is no need of taking account of the sexual difference of physiological conditions, are suitable materials for the study of lethal action, though they are considerably susceptible to drowning.

### II. Materials and Method

The worker of the ant, *Cremastogaster brunnea matsumurai* Forel, which has been adopted as the test insect, is very sensitive even to the slightest stimuli reacting to them with the abdomen erected, at the top of which a drop of milk-white stinking liquid is secreted. When dipped into some liquid, water or insecticidal mixture, it shows the similar reflex at the end of a certain struggling period, abruptly turning over the abdomen upright with the legs and antennae stretched out. The "abdomen erecting reflex" as it has been named by the writers marks the yielding point distinctly in the lethal process, after which any activity of the insect is arrested, and serves as an exact indicator to determine the end point of lethal time.

The apparatus used for measuring the lethal time consists of a circular electric water thermostat, 25 cm in diameter by 25 cm high, and a small glass beaker, 5 cm in diameter by 6 cm high, fixed in the centre of the water bath half immersed into water. The insects, lively enough within a few hours after capture, were put one

by one into the beaker containing 5 cc of test agent and the individual lethal time was measured in seconds, the end of which was determined by the completion of the abdomen erecting reflex i.e. by the moment when the angle between the abdomen and the body axis attains  $90^\circ$ .

Water, kerosene (distillate at  $320^\circ\text{C}$ ), and pyrethrin were chosen as the lethal components. For the convenience of dilution, the last two poisons were used in the form of emulsions, the original mixtures of which were prepared after the formulae shown in Table 1. Pyrethrum emulsion is a mixture of 1.5 % pyrethrin extract and kerosene.

Table 1. *Composition of the emulsions (%)*

	Kerosene emulsion	Pyrethrum emulsion
1.5 % pyrethrin extract .....	0	20
Soap .....	20	15
Light oil .....	50	50
Sulphonated oil .....	5	5
Water .....	25	10

100 individuals being used for each of 43 experiments varying in temperature and in concentration of the emulsions, 4,300 individuals were tested from June 11 to July 5, 1947. The room temperature recorded during the experiments ranged from  $21.5^\circ$  to  $28.5^\circ\text{C}$  ( $24.9^\circ\text{C}$  in average).

### III. *General Survey on the Distribution of Lethal Times*

Two series of data were obtained by experiments different in procedure, one at  $20^\circ\text{C}$  with water and the emulsions varying in concentration and the other with water and the emulsions diluted 1:100 at temperatures ranging from  $10^\circ$  to  $40^\circ\text{C}$  in  $5^\circ\text{C}$  increments. In the first place, the general survey on the distribution of lethal times is made for each of them. When the individual lethal times are grouped into the class intervals of 10 seconds, there are obtained frequency polygons of slightly skewed shape with the modes deviated to the left side of the arithmetic means, which would be classified into the V-type of Pearson's distribution curves. Some of these polygons are illustrated in Figs. 1 and 2, which show that, as dilution D is augmented and temperature  $t$  is lowered, the distributions become more and more dispersed and irregular and that the sites of mode as well as those of arithmetic mean move gradually in the opposite direction to the origin, the deviation between the two averages becoming larger. In kerosene emulsion, the influence of dilution is observed more remarkably than in pyrethrum emulsion down to  $D=200$ , beyond which the distribution stays in a stationary condition. It is, however, far less dispersed than that of water. Since the mode of distribution of lethal times is, as is generally the case for most biological phenomena, far from being normal, the variations of the measurements should not be regarded merely as errors but ought to be analysed statistically.

### IV. *Analysis of the Experimental Data*

If it is assumed that the lethal effect of a toxic agent upon each individual of test insects would be produced in the group experiment in the same process as in the



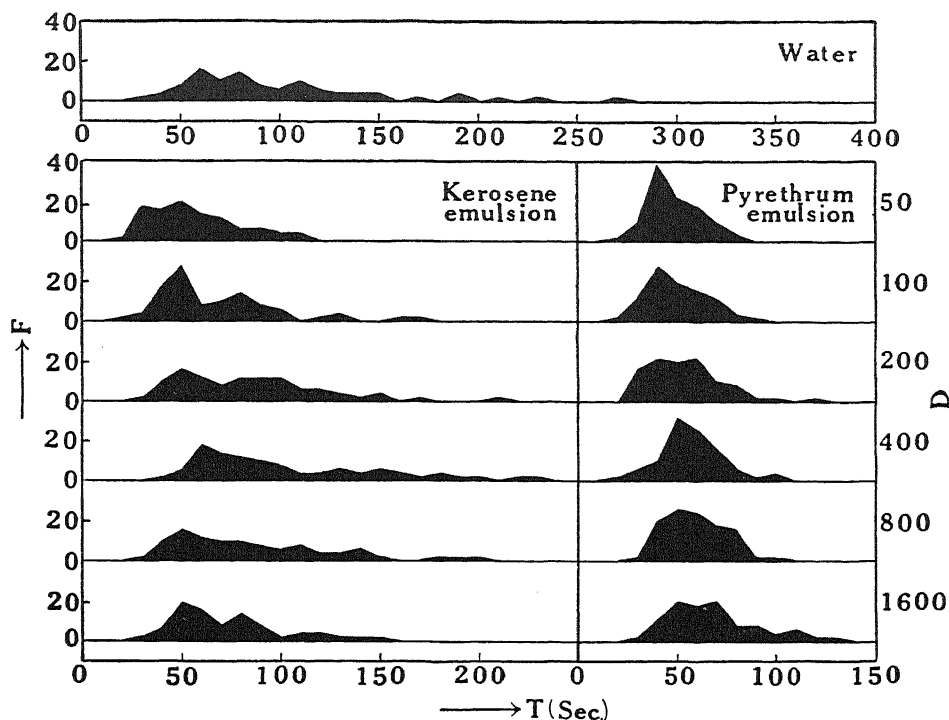


Fig. 1. Frequency distributions of lethal times at 20° C by the emulsions varying in dilution  $D$ . single or individual observation, the time-mortality curve is to be derived theoretically from the frequency distribution curve  $F(T)$  of individual lethal times  $T$ , which is integrated from 0 to  $T$  to give the percentage mortality  $P$  at a given time  $T$ :

$$P = \int_0^T F(T) dT.$$

On this assumption, the same reasoning leads to the possibility of deriving further the dosage- and temperature-mortality curves from the inferred time-mortality curves for various concentrations and temperatures. The per cent mortality  $P_T$  at time  $T$  in the cumulative frequency table (an inferred time-mortality table) for a given concentration  $C$  or temperature  $\theta$  may be regarded theoretically identical to the per cent mortality  $P_C$  or  $P_\theta$  at  $C$  or  $\theta$  in the real dosage- or temperature-mortality table after a given time  $T$ . When the variates are restricted to  $T$ ,  $C$ , and  $\theta$ , other factors being kept constant, and if the susceptibilities among the population of insect are assumed to be distributed continuously over each of these axes,  $P$  may be expressed as a certain integral function  $\Phi$  of these three components:

$$P = \phi(T, C, \theta).$$

Since the equation involves four variables, the relation between any two of them is able to be determined, the other two being fixed. In the present cases, there are following six series of statistical lethal curves to be expected through the combination of two variables:

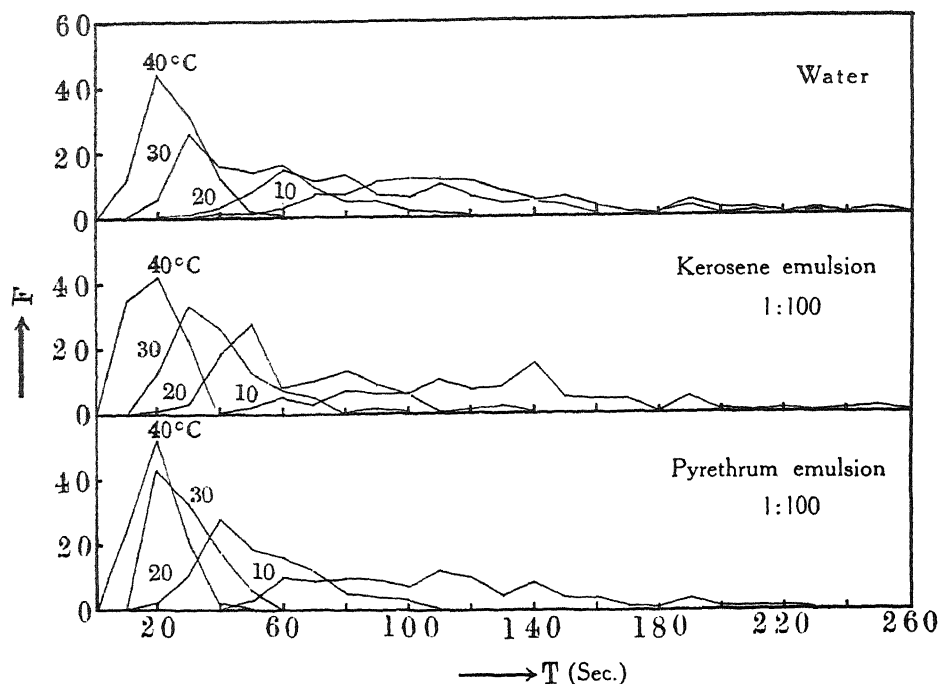


Fig. 2. Frequency distributions of lethal times at various temperatures.

Time-mortality curves for  $C$  and  $\theta$  fixed,  
 Dosage-mortality curves for  $T$  and  $\theta$  fixed,  
 Temperature-mortality curves for  $T$  and  $C$  fixed,  
 Time-dosage curves for  $\theta$  and  $P$  fixed,  
 Time-temperature curves for  $C$  and  $P$  fixed, and  
 Dosage-temperature curves for  $T$  and  $P$  fixed.

On the other hand, a series of curves consists of two systems practically different in character, each containing curves corresponding to various values of each one of the other two variables fixed. In other words, it is represented by two parametric equations. There are four systems of curves conceivable, which have been termed by the writers the *isochrons*, *isodoses*, *isotherms*, and *isomorts* according to the parameters concerned. These lethal curves will be computed and analysed statistico-physiologically in the following chapters.

### V. Time-mortality Curves

The writers begin with the elucidation of the precise features of the time-mortality curves which will serve as the basis for analysing the other lethal curves. The statistical treatment of the time-mortality curves by means of probability integral function was attempted by Davey as early as 1919 in his study on the effect of small X-ray upon the survival time of *Tribolium confusum*. Bliss (1937) has elaborated the method for computing the time-mortality data based upon the principles of linear transformation of the cumulative frequency curve.

Since the distribution of lethal times is asymmetrical as shown in Figs. 1 and 2, the

same principles are likely to be applied for the present cases. The expected per cent mortality  $P$ , which has been obtained by cumulating successively the frequency  $F$  in the interval of 1 second, plotted against the logarithm of time  $t$  ( $=\log T$ ), yields a typical symmetrical sigmoid curve, two examples (water and pyrethrum emulsion 1:100 at 20°C) of which are given in Fig. 3 (white circles). If  $P$  is converted to  $p$ , the normal equivalent deviation (N.E.D.) of Gaddum (1933) i.e. the upper limit of the probability integral, the points transformed (black circles) lie regularly on a straight line, that is, the time-mortality regression line. It is the case for all the other experiments.

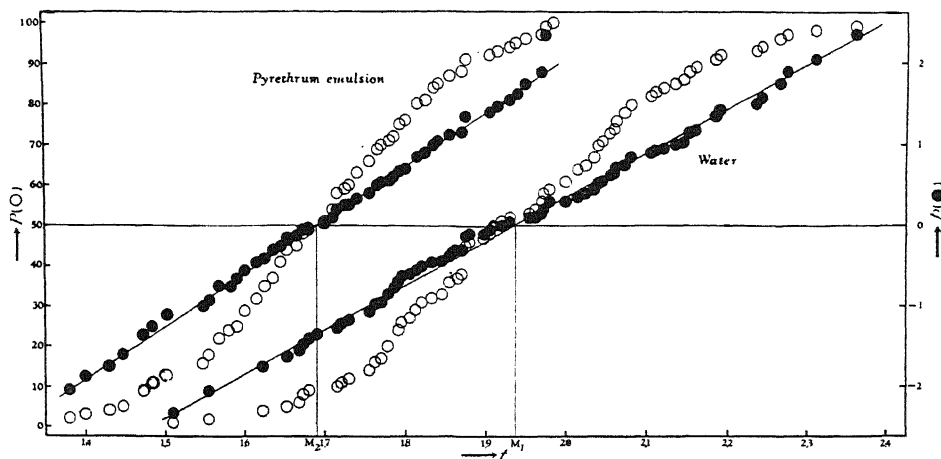


Fig. 3. Successively cumulated per cent frequencies  $P$  of lethal times at 20°C (white circles) plotted against the logarithm of time  $t$  ( $=\log T$ ) and the results of transforming  $P$  to N.E.D.  $p$  (black circles).  $M_1$  and  $M_2$  are medians.

It is now proved satisfactorily that the vital resistibilities of the ants to the lethal actions of water, kerosene emulsion, and pyrethrum emulsion are distributed normally over the logarithmic axis of time. There are a few problems to be noted in connection to these considerations. The fact that the skewed distribution curves which would be classified into the V-type of Pearson's distribution curves are transformed into the normal curves suggests that there are likely to exist numbers of distributions observed in biology which are to be reduced to the normal curves if only the abscissae are converted to their certain appropriate functions, the forms of which are considered to be significant in the scope of theoretical biology.

The arithmetic mean of lethal times or its inverse, the lethal velocity, is usually adopted as an indicator for the rate of lethal action. It is advisable, however, that the mode of the distribution of lethal times, corresponding to the median on the converted axis, should be preferred to the arithmetic mean for the representative value, because the deviation between the two averages is not small enough to neglect the error involved through adopting the arithmetic mean.

The possibility of linear transformation of time-mortality curves having been proved, the isodoses and isotherms will be computed by the method devised by Bliss (1937) and modified by Ohsawa and Nagasawa (1947). For simplification of calculation and convenience of analysis, the class limits are taken in a geometric series i.e. in the

Table 2. *Per cent cumulative frequency tables of log lethal times  $t$  at 20° C with the emulsions of various dilutions  $D$* 

	Dilution	Class t (=log T)													
	D	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5
Kerosene emulsion	50		1	1	16	30	48	68	84	97	100				
	75			1	9	18	36	56	77	87	92	97	98	100	
	100			1	1	16	42	60	73	93	97	99	100		
	150				4	8	19	47	71	86	94	99	100		
	200					7	23	37	49	72	89	96	98	99	100
	300				3	9	18	39	61	80	93	100			
	400				1	5	18	38	56	72	83	92	97	99	100
	600				2	8	20	43	67	80	92	100			
	800				2	7	19	37	54	72	86	97	98	100	
	1200				1	7	22	39	67	81	94	98	100		
1600				2	4	12	38	60	81	90	99	100			
Pyrethrum emulsion	50			2	10	38	64	85	100						
	75	1	1	1	12	29	57	84	98	100					
	100			3	13	29	51	76	91	100					
	150		1	3	12	28	61	87	97	99	100				
	200				7	28	49	75	92	97	100				
	300				5	18	50	73	89	100					
	400			1	4	11	40	72	94	100					
	600			1	5	14	39	64	87	97	100				
	800					8	38	71	95	99	100				
	1200				1	14	38	71	91	99	100				
1600				2	13	30	53	76	91	99	100				

logarithm of time,  $t$ . Cumulative frequencies, which are inferred to be identical to the per cent mortalities  $P$ , are given in Tables 2 and 3 for parameters  $C$  ( $=1/D \times 10^4$ ) and  $\omega$ . When  $P$  is transformed to  $p$  (N.E.D.), systems of time-mortality regression isodoses at 20° C

$$p = \frac{1}{\sigma_c} (t - \bar{t}_c)$$

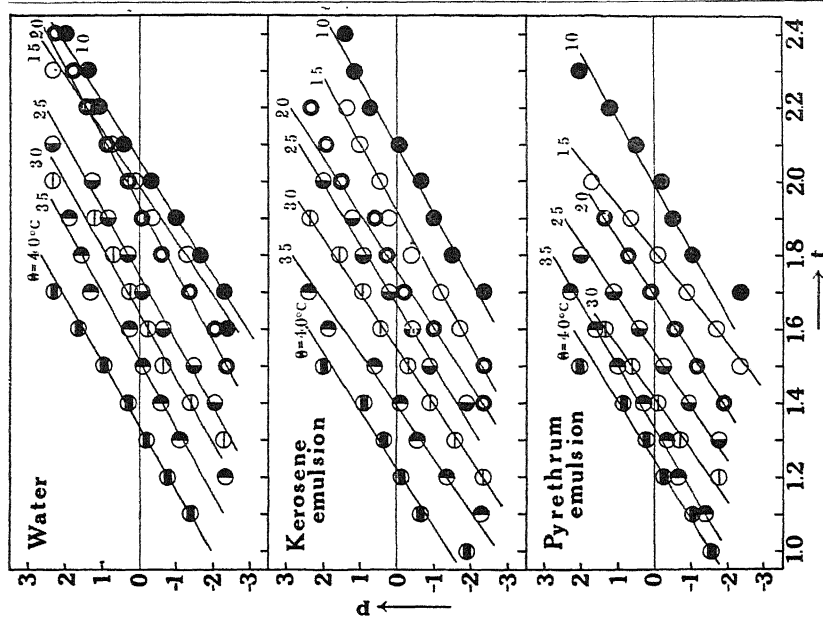
and systems of time-mortality regression isotherms

$$p = \frac{1}{\sigma_\omega} (t - \bar{t}_\omega)$$

are obtained, where  $\bar{t}$  is the median corresponding to the mode  $\bar{T}$  of the distribution of lethal times and  $\sigma$  is the standard deviation of the transformed normal curve. The latter are diagrammed in Fig. 4. The probability of fitness between the regression lines and the observations calculated for each system is large enough for the hypothesis of linear transformation to be relied upon sufficiently: .998 and .971 for the isodosal systems of kerosene emulsion and pyrethrum emulsion; .871, .745, and .468 for isothermal systems of water, kerosene, and pyrethrum emulsions, respectively. Values

Table 3. *Per cent cumulative frequency table of log lethal times  $t$  at various temperatures*

	Temperature $\theta$ ( $^{\circ}$ C)	Class $t$ ( $= \log T$ )															
		1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5
Water	40		8	21	43	59	83	95	99	100							
	35			1	13	27	45	60	87	94	97	100					
	30				1	8	25	41	59	76	89	99	100				
	25					2	7	26	45	59	79	90	99	100			
	20						1	2	9	26	47	61	80	92	97	100	
	15								1	10	35	52	76	90	99	100	
	10							1	1	5	15	36	68	87	92	98	100
Kerosene emulsion 1:100	40	3	25	45	63	81	98	100									
	35		1	9	30	49	74	91	99	100							
	30			1	6	18	38	68	82	94	99	100					
	25					3	19	34	58	81	88	98	100				
	20					1	1	16	42	60	73	93	97	99	100		
	15						1	5	12	34	57	67	84	91	100		
	10								1	7	16	26	48	77	87	92	100
Pyrethrum emulsion 1:100	40	6	15	41	59	81	98	100									
	35		8	25	40	61	84	94	99	100							
	30			4	24	46	72	91	100								
	25				4	17	41	66	87	98	100						
	20					3	13	29	51	76	91	100					
	15						1	5	18	47	74	96	100				
	10								1	14	29	43	71	89	98	100	

Fig. 4. Time-mortality regression isotherms in the range of temperature  $\theta$  from  $10^{\circ}$  to  $40^{\circ}$  C.

of  $\sigma$ ,  $\bar{t}$ , and  $\bar{T}$  ( $=\log t$ ) computed for each regression line and the arithmetic mean  $T_m$  of the lethal times are given in Tables 4 and 5. The most striking character of the results is the fact that  $\sigma$  retains approximately constant value characteristic to the agent and independent of parameters  $C$  and  $\phi$ , namely, that the regression lines belonging to a given system run almost parallel to one another, the fact which is very interesting from the statistico-physiological point of view. It appears, however, to be the natural consequence which ought to be induced theoretically from the principles of linear transformation of the mortality curves. If any two regression lines, isodoses or isotherms, intersected with each other at a point, the lethal effect or the mortality would be reversed below that point, lower concentration yielding higher mortality. For the same reason, the constancy of  $\sigma$  in a isochronal system is also expected theoretically and has been proved practically as shown in the later chapters.

Table 4. *Characteristics of the time-mortality regression isodoses and the arithmetic mean of the lethal times calculated directly from the measurements at 20° C*

	Dilution D	Standard deviation $\sigma_c$	Log median lethal time $\bar{t}_c$	Median lethal time $\bar{T}$ (sec.)	Arithmetic mean of lethal times $T_m$ (sec.)
Kerosene emulsion 1 : 100	—	0.189	1.94	86.4	99.5
	50	0.181	1.70	49.9	55.2
	75	0.211	1.78	60.3	67.7
	100	0.171	1.77	58.5	64.1
	150	0.166	1.82	66.4	71.5
	200	0.203	1.88	75.1	83.1
	300	0.178	1.85	70.6	76.6
	400	0.207	1.89	77.6	87.7
	600	0.175	1.84	69.3	74.6
	800	0.195	1.88	75.6	75.4
	1200	0.168	1.84	69.4	74.3
	1600	0.163	1.86	73.2	75.6
Pyrethrum emulsion 1 : 100	50	0.119	1.66	45.4	47.2
	75	0.147	1.66	46.2	49.3
	100	0.159	1.69	48.8	52.1
	150	0.136	1.66	44.8	48.7
	200	0.149	1.70	50.2	54.1
	300	0.138	1.72	52.1	56.6
	400	0.122	1.73	53.5	56.1
	600	0.177	1.74	55.3	58.2
	800	0.103	1.74	54.7	56.6
	1200	0.117	1.74	54.5	57.1
	1600	0.155	1.79	61.0	64.6

Table 5. *Characteristics of the time-mortality regression isotherms and the arithmetic mean of the lethal times calculated from the measurements*

	Temperature (°C)	Standard deviation $\sigma$	Log median lethal time $\bar{t}$	Median lethal time $\bar{T}$ (sec.)	Arithmetic mean of lethal times $T_m$ (sec.)
Water	10	0.159	2.05	111.8	119.3
	15	0.154	1.99	94.5	104.7
	20	0.189	1.94	86.4	99.5
	25	0.185	1.74	55.4	61.8
	30	0.187	1.65	44.9	49.2
	35	0.185	1.53	33.5	36.7
	40	0.168	1.34	21.9	24.2
Kerosene emulsion 1 : 100	10	0.190	2.10	95.3	135.8
	15	0.197	1.90	79.9	87.5
	20	0.171	1.77	58.5	64.1
	25	0.166	1.67	46.4	50.5
	30	0.157	1.54	35.1	38.0
	35	0.148	1.40	24.9	27.2
	40	0.161	1.24	17.3	18.8
Pyrethrum emulsion 1 : 100	10	0.165	2.00	100.9	108.6
	15	0.123	1.81	64.6	67.2
	20	0.159	1.69	48.8	52.1
	25	0.139	1.54	34.4	36.9
	30	0.138	1.42	26.4	27.8
	35	0.172	1.34	21.7	24.5
	40	0.158	1.25	17.8	19.7

The average values of  $\sigma$  calculated for the two systems of a same agent coincide very well (Table 6). Among the three agents,  $\sigma$  is larger in the following order:

Table 6. *Average value of  $\sigma$  for each system of time-mortality regression lines*

	Regression isodoses	Regression isotherms
Water .....	.18	.19
Kerosene emulsion .....	.17	.18
Pyrethrum emulsion .....	.15	.14

Water > kerosene emulsion > pyrethrum emulsion.  $T_m$  is always larger than  $\bar{T}$  and the deviation between the two increases with  $\bar{T}$ .  $\bar{T}$  varies with parameter, the decrease being especially rapid with rising temperature. These relations will be later discussed in details.

## VI. Dosage-mortality Curves

Assuming the independence of the individual lethal process, it is possible, as mentioned above, to derive the dosage-mortality curves theoretically from the time-mortality relations for varying concentrations obtained by cumulating the distribution frequency of lethal times. Every column of Table 2 provides the per cent mortalities at various concentrations after a given time of immersion.

The implication of sigmoid character of the dosage-mortality curve has been fully elucidated by Gaddum (1933), Hemmingsen (1933), Bliss (1934, 1935, and 1938), and O'Kane et al (1934), based upon the hypothesis that the susceptibilities of test insects should be distributed normally over the logarithm of dosage. This principle is expected to be available also for the present experiments, and the Table 2, of which  $P$  is transformed to  $p$  and  $C$  to  $c$  ( $=\log C$ ), yields systems of parallel straight lines—dosage-mortality regression isochrons (Fig. 5):

$$p = \frac{1}{\sigma_t} (c - \bar{c}_t)$$

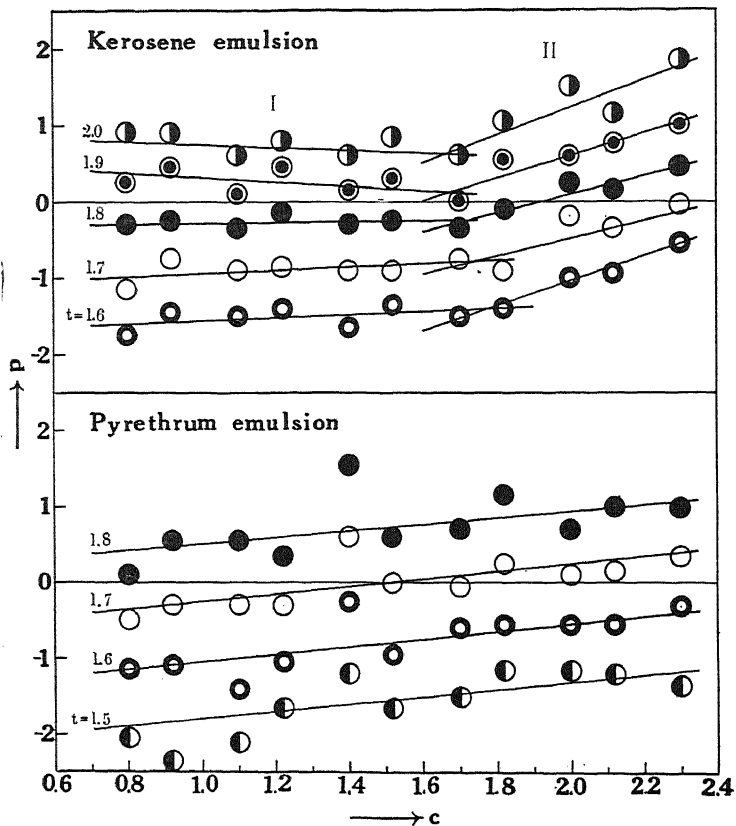


Fig. 5. Dosage-mortality regression isochrons at 20° C in the range of log time  $t$  from 1.5 to 2.0.



$p$  increases uniformly with  $t$  at all concentrations in the range tested. In kerosene emulsion, a phenomenon of "joint action" (Bliss, 1939) is acknowledged and a system of isochrons is divided into two groups of regression lines, group I and group II, different in slope and intersecting in the vicinity of  $c=1.7$ . Since the isochrons I are regarded nearly horizontal,  $p$  is considered to be independent of  $c$  below  $c=1.7$ . This fact might mean that the toxic property of kerosene remains masked up to  $c=1.7$  with the lethal action of the dispersion medium which is comparatively strong. There are no median lethal doses for pairs of regression lines, such as those for  $t=1.9$  and  $t=2.0$ , which have breaks above  $p=0$ .

Table 7 shows the values of  $\sigma_t$  and  $\bar{C}_t$  computed for the isochrons except isochrons

Table 7. *Characteristics of the dosage-mortality regression isochrons at 20° C.*  
The values in parentheses are not realized

		Log time $t$	Standard deviation $\sigma_t$	Median lethal concentration $\bar{c}_t$	Average mortality in N.E.D. $\bar{p}_t$
Kerosene emulsion	I	1.6	—	—	— 1.51
		1.7	—	—	— 0.89
		1.8	—	—	— 0.29
		1.9	—	—	0.23
		2.0	—	—	0.74
	II	1.6	0.604	2.63	
		1.7	0.764	2.33	
		1.8	0.813	1.91	
		1.9	0.669	(1.60)	
		2.0	0.550	(1.31)	
Pyrethrum emulsion		1.5	2.02	4.63	
		1.6	1.76	2.88	
		1.7	2.10	1.54	
		1.8	2.07	1.98	

I of kerosene emulsion, which are reasonably horizontal and of which the mean mortalities  $\bar{p}_t$  are given in the table. The equation for them is, therefore, assumed as

$$p = \bar{p}_t$$

The values in parentheses would not be realized.

Time has little influence on  $\sigma_t$ , which is characteristic to the agent as it was in the case of time-mortality curves. On the average,  $\sigma_t$  of pyrethrum emulsion is about three times as large as that of kerosene emulsion. Relations between  $t$  and  $\bar{c}_t$  will be considered in the following chapter.

VIII. *Time-dosage Curves*

The relation between lethal or survival time  $T$  and concentration  $C$  in the toxic action has long and widely discussed among physiologists. Powers (1917) found in his study of toxic effect of salts on the gold fish that the inverse of lethal time plotted against concentration gives a curve of sigmoid character, by the slope of which he defined the toxic unit. Gersdorff adopted Powers' formula in his earlier work (1933), but later he found it improper (1935 and 1936). Curves of similar shape were obtained by Shackell (1925) and Campbell (1926). Meanwhile, a number of relations have been considered to hold between  $T$  and  $C$ , for example,

$$T \log \frac{1}{C} = K, (K: \text{constant})$$

by Carpenter (1927) in the lethal actions of soluble metallic salts on the fishes, and  $TC = K$

by Clark (1926) in the action of drugs on cells. Gersdorff (1935), pointing out that  $K$  is not constant in general, proposed a new criterion for the comparisons of toxicity. In his terms, the toxicity is defined by the reciprocal of the minimal product of concentration and survival time, which is proper to the chemical substance concerned. Ostwald (1909), in the lethal action of sea-water on *Gammarus pulex* de Geer, proposed for the first time the equation

$$TC^n = K, (K \text{ and } n: \text{constants}),$$

which has been demonstrated by many investigators, for example, Chick (1908), Paul (1910), Tröndle (1920), Cook (1926), Koizumi (1928), etc. with various organisms, and is universally adopted at present. Campbell (1926) analysed by applying this law to the sigmoid curve that he had observed in the toxic action of arsenic on the silk-worm into a pair of straight lines, which Bliss (1936) proved to be unified to a single straight line by taking the dosage per body weight as the abscissa.

From the statistico-physiological point of view, there are series of time-concentration curves corresponding to different mortalities, i.e. various time-concentration isomorts conceivable for a given agent. On the other hand, the possibility of linear transformation of mortality curves suggests that the median is most appropriate as the representative value of lethal time or dose. For this reason as well as for the simplification of analysis, the writers will restrict in the present paper the isomorts to the median lethal curves, of which the sampling and experimental errors should be minimal. There are two possible procedures by which the time-concentration isomorts are figured. For instance, two different sorts of median lethal curves can be drawn: by plotting against  $C$  the median lethal time  $\bar{T}$  computed from the time-mortality isodoses and by plotting against  $T$  the median lethal dose  $\bar{C}$  computed from the dosage-mortality isochrons. In Fig. 6 are shown these two series of time-concentration relations, one of which ( $I_c$  and  $II_c$ ) is derived from Table 4 and the other ( $I_t$  and  $II_t$ ) from Table 7, where  $C$  and  $T$  are transformed into their logarithms.  $I_t$  of kerosene emulsion is the level of median lethal time  $\bar{t}_t$  computed from the relation of  $t$  to the mean mortality  $\bar{p}_t$  of the isochrons  $I$  assumed to be horizontal. Broken circles and lines denote the parts which are not realized. Every series or group of points plotted may be regarded to be in a linear relation, i.e.

$$t = -nc + \log K, (n \text{ and } K: \text{constants}),$$

which shows clearly that the law of Ostwald,

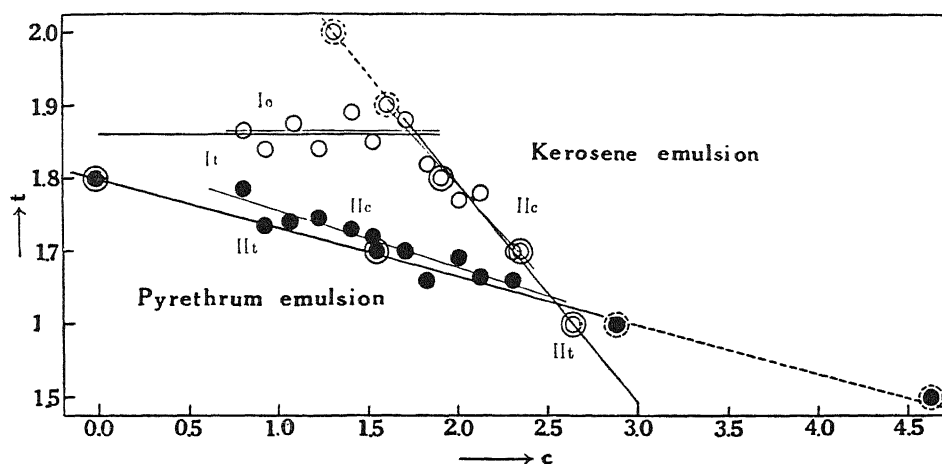


Fig. 6. Median lethal time-dosage regression lines at 20° C,  $I_c$  and  $II_c$  (single circles) being derived from the time-mortality isodoses, and  $I_t$  and  $II_t$  (double circles) from the dosage-mortality isochrons. Broken circles and lines denote the parts which would not be realized.

$$TC^n = K,$$

is most applicable to the present cases. It is noted, further, that the two series of median lethal regression lines,

$$I_c \text{ or } II_c : t = -n_c C + \log K_c$$

and

$$I_t \text{ or } II_t : t = -n_t C + \log K_t$$

run very close to each other. Table 8 shows that the values for  $n_c$  and  $K_c$  agree tolerably with those for  $n_t$  and  $K_t$ , respectively. These facts confirm that  $t$  is correlated

Table 8. The values of  $n$  and  $K$  for the median lethal time-dosage curves

		$I_c$ and $II_c$		$I_t$ and $II_t$	
		$n_c$	$K_c$	$n_t$	$K_t$
Kerosene emulsion	I	.00164	72.61	—	72.57
	II	.267	208.5	.297	240.6
Pyrethrum emulsion		.0764	67.26	.0655	62.78

completely as well as normally to  $c$  with respect to the distribution of resistibilities, namely, that there exists a linear functional relationship between  $t$  and  $c$  for a given lethal effect when viewed from the statistical standpoint. From the assumption that the susceptibilities should be distributed normally over both variables concerned, with  $\sigma$  remaining constant for each of them, the linear relationship between them and the coincidence of the two regression lines are also to be induced theoretically solely by means of simple mathematical operations, which shall be given by the writers on another opportunity.

Though pyrethrum emulsion gives a unique regression line,  $II_c$  or  $II_t$  in the range of concentration tested, it is supposed reasonably that, the toxic action of pyrethrin being preceded by that of kerosene at the higher concentrations, there would appear an abrupt transition from II to III in the vicinity of  $c=2.5$ , if the two agents act more or less independently of each other. Since the regression line I of kerosene emulsion may be regarded as horizontal, the median lethal time remains constant ( $t_t=1.86$ ) for all concentrations below  $c=1.7$ . Then,  $\bar{p}_t$  from Table 7 is plotted against  $t$  in Fig. 7 (black circles) and compared with the time-mortality regression line at  $20^\circ\text{C}$  of water (white circles). The regression equations for them are given as

$$\text{Kerosene emulsion: } p = \frac{1}{0.178} (t - 1.86)$$

$$\text{Water : } p = \frac{1}{0.189} (t - 1.94).$$

While their slopes are approximately equal, their positions deviate a little from each other. Consequently, the regression line I of kerosene emulsion should not be ascribed directly to the lethal action of water. It might be due to a certain physical action, e.g. surface activity, which is less susceptible to dilution, by some auxiliary agent such as soap.

There is another interesting fact to be noted that the mean lethal velocity i.e. the inverse of median lethal time, when plotted against ordinary concentration, yields a velocity-concentration curve of sigmoid character, which is considered to be identical to the curves obtained by Powers, Shackell, and Campbell. These curves must be, therefore, reexamined and analysed statistically.

#### IX. Temperature Coefficients of Lethal Velocity

Of temperature coefficients, which have been proposed in biology, three expressions,  $Q_{10}$  of van't Hoff,  $\mu$  of Arrhenius, and  $b$  of Bélehraděk are most popular. These three temperature coefficients have been computed for the present data, the lethal velocity being defined by the reciprocal of lethal time as  $V=1/T \times 10^3$ . The results are reported in Table 9. None of them has proved to be constant. In water and kerosene emulsion, they rather show increases at higher temperatures, a phenomenon which contradicts with the general rule. It has been pointed out by many biologists that generally  $Q_{10}$

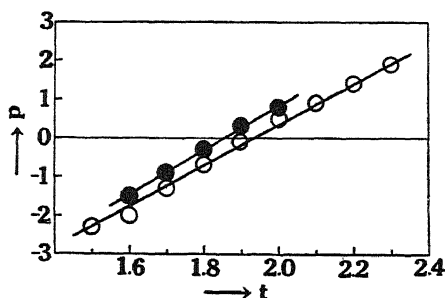


Fig. 7. Time-mortality regression line obtained by plotting against log time  $t$  the average mortality  $\bar{p}_t$  (black circles) computed from the dosage-mortality isochrons I of kerosene emulsion at  $20^\circ\text{C}$ , as compared with the time-mortality regression line of water at  $20^\circ\text{C}$  (white circles).

	Temperature $\theta$ ( $^{\circ}\text{C}.$ )	Mean lethal velocity $\bar{V}$	$Q_{10}$	$\mu$	b
Water	10	8.945	1.32	4458	0.338
	15	10.59	1.27	4043	0.417
	20	11.57	2.43	15518	1.99
	25	18.05	1.53	7578	1.15
	30	22.27	1.80	10924	1.90
	35	29.85	2.35	16454	3.20
	40	45.75			
Kerosene emulsion 1 : 100	10	10.49	2.46	14632	1.11
	15	12.51	1.87	10520	1.08
	20	17.09	1.58	7921	1.02
	25	21.45	1.77	10296	1.57
	30	28.53	1.97	12677	2.17
	35	40.08	2.08	14141	2.75
	40	57.87			
Pyrethrum emulsion 1 : 100	10	9.911	2.44	14525	1.10
	15	15.49	1.75	9389	0.968
	20	20.47	2.02	12246	1.57
	25	29.07	1.70	9523	1.45
	30	37.85	1.49	7411	1.29
	35	46.17	1.48	7591	1.48
	40	56.24			

is not the real constant in biological processes and that it decreases steadily with rising temperature (Bělehraděk, 1935), though there are not a few investigators (Madsen und Nyman, 1907; Chick, 1908; Zehl, 1908; Koizumi, 1928; Gersdorff, 1943; etc.) who maintain that the lethal action should follow the law of van't Hoff (1884). While the value of  $\mu$  should remain constant in a certain range of temperature following the temperature characteristic theory of Crozier and his co-workers (1924, 1926, and 1927), it varies with temperature in the present cases.

In order to examine these circumstances in details, relations between  $\theta$  and  $v$  ( $=\log V$ ) and between  $1/\theta_a$  and  $v$  are represented graphically in Fig. 8, according (A) to the equation of Berthelot (1862),

$$V = Kq^{\theta}, \text{ (K and q: constants),}$$

and (B) to the equation of Arrhenius (1889),

$$-\frac{\mu}{2} \frac{1}{\theta_a}$$

$$V = K e^{\frac{\mu}{\theta_a}}, \text{ (K: constant; } \theta_a$$

: absolute temperature).

Neither of them proves to be linear. It is clearly seen in Fig. A that  $\log q$ , the angular coefficient of tangent, and, consequently,  $Q_{10}$  ( $=q^{10}$ ) vary with temperature. In water and kerosene emulsion, there are breaks in the vicinity of  $20^{\circ}\text{C}$ , above which the values of  $Q_{10}$  increase with rising temperature. For the latter, however, holds rather

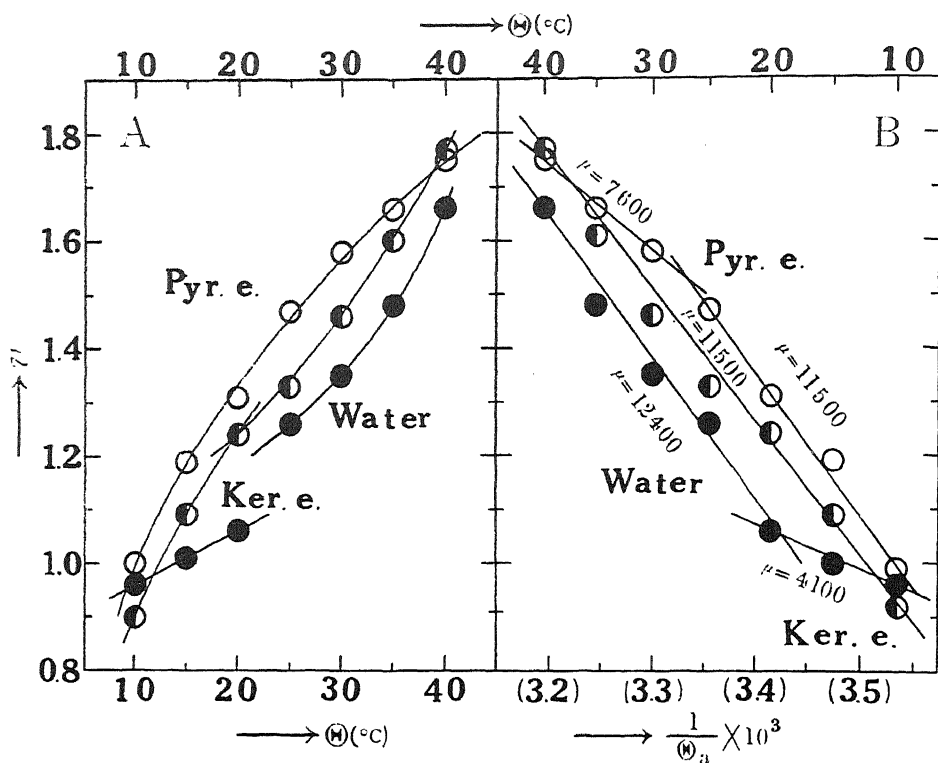


Fig. 8. Temperature-lethal velocity diagrams. A shows the relations between ordinary temperature and the mean log lethal velocity, and B the relations between the reciprocal of absolute temperature and the mean log lethal velocity.

better the theory of linear relationship between temperature and velocity proposed by Krough (1914) and others,

$$V = K (\Theta - A), \quad (K \text{ and } A: \text{constants});$$

and  $V$  plotted against  $\Theta$  yields a pair of straight lines intersecting at  $20^{\circ}\text{C}$ . In Fig. B, broken lines denote the parts to which the equation of Arrhenius is not applied at all. If it were possible to analyse these curves into straight lines,  $\mu$  of them would take the values as shown in Table 10. In water,  $\mu$  increases remarkably at higher temperatures. The fact is inconsistent with the general results which have ever been reported. The similar tendency is perceived in kerosene emulsion. Since there are serious objections to the theory of Crozier (Heilbrunn, 1925; Ludwig, 1928; Fulmer and Buchanan, 1929; Bělehrádek, 1928, 1929, 1930, 1932, and 1935), and, in fact, the thermokinetic law of Arrhenius does not hold for these cases, it should be reserved for the present to apply the theory of Crozier and to discuss the inner biokinetic mechanisms of lethal action in connection with the values of  $\mu$ .

As the value of  $b$  varies significantly with temperature as shown in Table 9, it is necessary to replace the first equation of Bělehrádek (1926), after which they have been

Table 10. *The values of  $\mu$  of lethal velocity*

	Range of temperature	$\mu$
Water	10°—20°C	4,134
	20°—40°C	12,434
Kerosene emulsion 1:100	10°—40°C	11,513
Pyrethrum emulsion 1:100	10°—25°C	11,513
	30°—40°C	7,553

calculated, 
$$T = \frac{K}{\theta^b}, \quad (K \text{ and } b: \text{constants}),$$

with the second one (1929), 
$$T = \frac{K}{(\theta - A)^b},$$

introducing the "biological zero"  $A$ . Computed for each agent,  $A$  gives the values: 48° C for water (25°—40° C), 63° C for kerosene emulsion (20°—40° C), and —14° C for pyrethrum emulsion (10°—40° C). With these values of  $A$  the variability of  $b$  is eliminated practically. Since there seems to be a possibility of expressing uniquely the temperature coefficients of lethal actions of the three agents only by adopting the equation of Bělehraděk, however the values of biological zero may be, the writers will discuss the following lethal curves concerning temperature on the assumption that the law of Bělehraděk should be applied to them.

#### X. Temperature-mortality Curves

When the mortalities transformed to  $p$  are plotted against the modified temperature axis converted to  $\vartheta$  ( $=\log |\theta - A|$ ) based upon the data given in Table 5, a system of parallel straight lines i.e. the temperature-mortality isochrons results for each agent

as shown in Fig. 9, whose equation is expressed as 
$$p = \frac{\pm 1}{\sigma_t} (\vartheta - \vartheta_t),$$

$\pm$  corresponding to  $(\theta - A) \gtrless 0$ . Breaks appear at 25° C in water and between 15° and 20° C in kerosene. It requires special attention that the isochrons I have also proved to be almost parallel as well as straight both in water and kerosene emulsion notwithstanding that the values of  $A$  have been computed for II alone. Large values of probability for the agreement between the observations and the regression lines (0.559 and 0.597 for I and II of water, 0.057 and 0.311 for I and II of kerosene emulsion, and 0.213 for pyrethrum emulsion) show that the hypothesis of linear transformation of temperature-mortality curves through the conversion of abscissa into  $\log |\theta - A|$  is highly reliable.

It is the most striking nature of this linear transformation that  $A$  is situated in such extraordinarily high temperatures as 48° C for water and 63° C for kerosene emulsion, while it is unusually low (—14° C) for pyrethrum emulsion. The lethal effects by water and kerosene are considered to differ substantially from that of pyrethrin on the thermobiokinetic aspect.

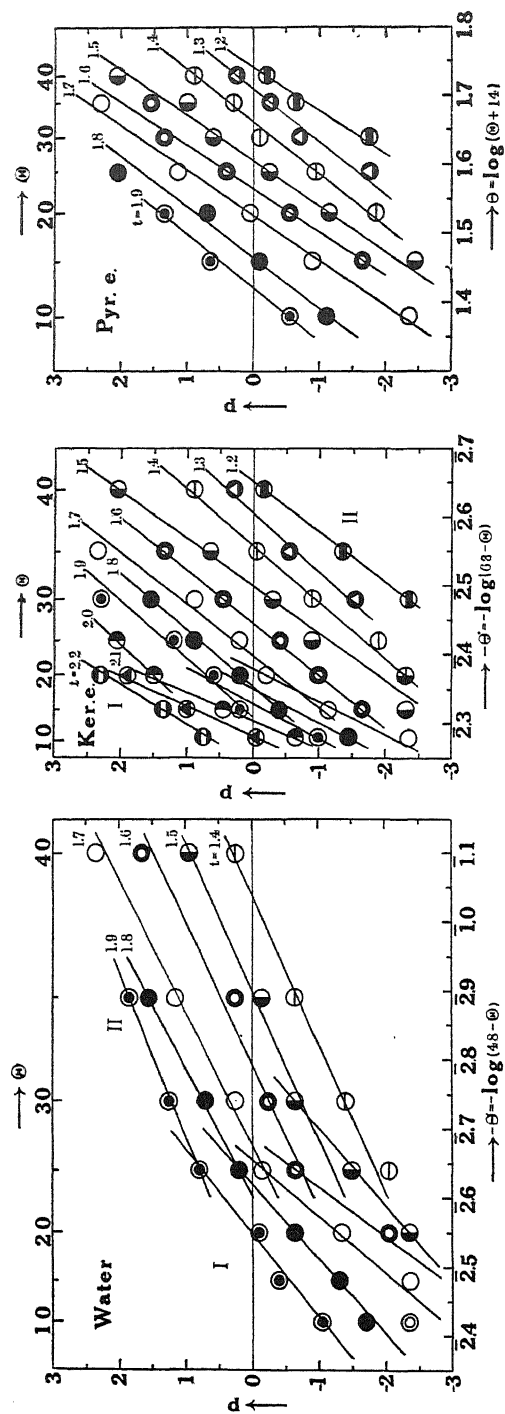


Fig. 9. Temperature-mortality regression isochrons in the range of log time  $t$  from 1.2 to 2.2.



The values of  $\sigma_t$ ,  $\bar{\vartheta}_t$  and  $\bar{\omega}_t$ , the median lethal temperature ( $\bar{\omega}_t = A - \log^{-1} \bar{\vartheta}_t$  for water and kerosene emulsion, and  $\bar{\omega}_t = \log \bar{\vartheta}_t - A$  for pyrethrum emulsion), are given in Table II. It is evident, as in the cases of the other mortality curves which have been considered, that the value of  $\sigma_t$  does not vary significantly with temperature among the isochrons belonging to a given system, although the ranges of errors are

Table II. *Characteristics of the temperature-mortality regression isochrons and the values of median lethal temperature. The values in parentheses are not realized*

		Log time $t$	Standard deviation $\sigma_t$	Median $\bar{\vartheta}_t$	Median lethal temperature $\bar{\omega}_t$ ( $^{\circ}\text{C}.$ )
Water	I	1.5	0.118	(1.18)	(32.8)
		1.6	0.0728	(1.31)	(27.5)
		1.7	0.0783	(1.35)	(25.7)
		1.8	0.112	1.38	23.9
		1.9	0.126	1.46	19.5
	II	1.4	0.216	0.957	38.9
		1.5	0.222	1.10	35.4
		1.6	0.210	1.21	31.9
		1.7	0.190	1.32	27.0
		1.8	0.191	(1.40)	(22.8)
Kerosene emulsion 1:100	I	1.7	0.0467	(1.62)	(21.2)
		1.8	0.0559	1.65	16.6
		1.9	0.0584	1.67	15.8
		2.0	0.0420	1.70	13.4
		2.1	0.0442	1.72	10.6
		2.2	0.0596	1.76	5.05
	II	1.2	0.0752	1.35	40.6
		1.3	0.0892	1.39	38.3
		1.4	0.0820	1.44	35.5
		1.5	0.0701	1.50	31.4
		1.6	0.0763	1.55	27.3
		1.7	0.0748	1.60	23.1
		1.8	0.0820	1.65	18.4
		1.9	0.0835	(1.69)	14.2
Pyrethrum emulsion 1:100		1.2	0.0620	1.74	41.0
		1.3	0.0776	1.71	37.2
		1.4	0.0766	1.66	31.8
		1.5	0.0670	1.61	26.5
		1.6	0.0661	1.56	22.7
		1.7	0.0648	1.52	19.4
		1.8	0.0727	1.46	15.2
		1.9	0.0767	1.42	12.2

comparatively large. In water and kerosene emulsion the groups I are steeper in slope than groups II. The relation, which is likely to be connected to the extraordinarily high values of  $A$ , is contrary to that of dosage-mortality regression isochrons. Since the temperature is different fundamentally from the dosage in the character as stimulus, the duality of temperature-mortality regression isochrons should not be paralleled to that of dosage-mortality regression isochrons.

### XI. Time-temperature Curves

The median lethal time-temperature curves are obtained also in two ways: by plotting as usual the median lethal time against temperature based upon the time-mortality isotherms (Fig. 4 and Table 5) and by plotting the theoretical median lethal temperature against time based upon the temperature-mortality isochrons (Fig. 9 and Table 11). Fig. 10 shows the results by these two methods, the black circles being determined by

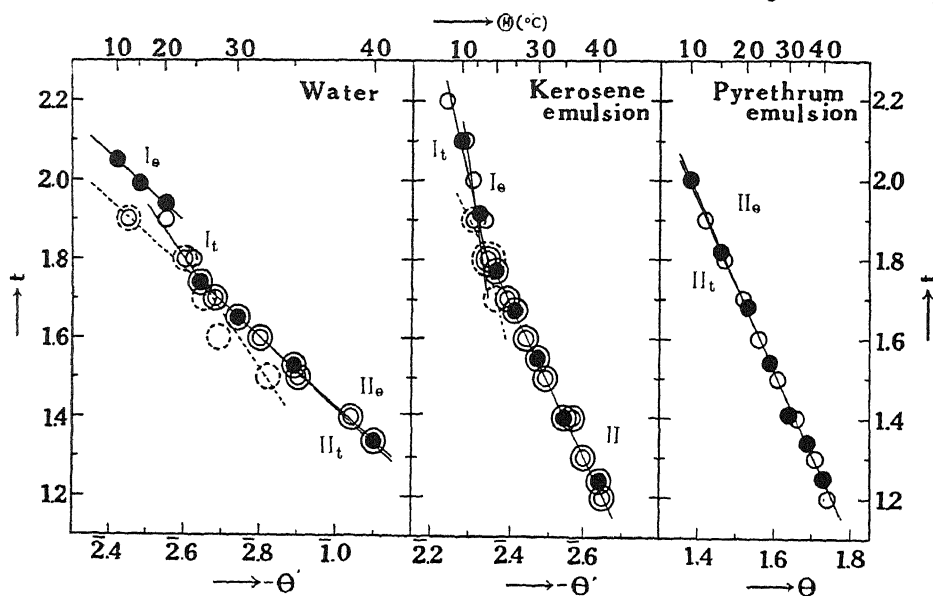


Fig. 10. Median lethal time-temperature regression lines,  $I_\theta$  and  $II_\theta$  (black circles) being derived from the time-mortality isotherms, and  $I_t$  and  $II_t$  (white circles) from the temperature-mortality isochrons. Broken circles and lines denote the parts which would not be realized.

the former and the white circles by the latter. Both of them indicate linear relations, whose equations are given as follows:  $I_\theta$  and  $II_\theta$ :  $t = k_\theta \pm b_\theta \vartheta$

$$I_t \text{ and } II_t: t = k_t \pm b_t \vartheta$$

$\pm$  corresponding to  $\vartheta' = \log(A - \theta)$  for water and kerosene emulsion, and  $\vartheta = \log(\theta - A)$  for pyrethrum emulsion, respectively. The characteristic values are given in Table 12. Coincidence of these two regression lines, showing functional relations between time and temperature with regard to the lethal action, emphasizes the probability of the assumption that the susceptibilities are distributed normally over the modified temperature axis  $\vartheta$ .

Table 12. *The values of k and b for the median lethal time-temperature curves*

		$k_g$	$k_t$	$b_g$	$b_t$
Water	I	0.716	1.721	0.843	1.48
	II	0.565	0.546	0.864	0.879
Kerosene emulsion 1:100	I	6.291	5.797	4.53	3.65
	II	2.542	2.520	1.98	1.99
Pyrethrum emulsion 1:100					
		4.945	4.903	2.14	2.12

Considering together what have been discussed about the temperature curves, it is concluded that the relations between lethal effect and temperature, when viewed from the statistico-physiological standpoint, are expressed most satisfactorily by the law of Bělehrádék, according to which the mortality  $p$  after a given time  $T$  is given by

$$e^{\mp p} = \frac{K_t}{| \Theta - A |^{bT}}$$

and the time  $T$  taken to produce a given mortality  $p$  by

$$T = \frac{K_p}{| \Theta - A |^{\pm b_p}}$$

The extraordinarily high values of  $A$ , of which there is scarcely any report, is no longer called the "biological zero" in the original sense of the word. The theoretical elucidation of its significance, as well as that of the plurality of the temperature-mortality regression line, is a problem left to further investigations.

## XII. Summary

Individual lethal times by water, kerosene emulsion, and pyrethrum emulsion were measured with the workers of *Cremastogaster brunnea matsumurai* Forel, the "abdomen erecting reflex" being used as an indicator for determining the yielding point. Assuming that the lethal action upon individuals should be produced independently in the group experiments, the time-, dosage-, and temperature-mortality curves, time-dosage curves, and time-temperature curves have been inferred from the frequency distributions of lethal times and subjected to the statistico-physiological analysis, which has revealed some interesting facts as follows:

1. If the inferred mortalities transformed to the normal equivalent deviation  $p$  are plotted against the logarithm of one of the variables—time, concentration, and temperature in biological scale—a system of parallel regression lines results, which are named isodoses, isotherms, or isochrons, according to the parameter concerned. It follows, therefore, that the susceptibilities of the test insects to a given agent are distributed normally over any one of the variables with a constant standard deviation characteristic to the agent and independent of the other variables.

2. The two median lethal time-dosage or time-temperature relations different in origin, one derived from the time-mortality isodoses or isotherms and the other from the dosage- or temperature-mortality isochrons, yield straight lines, which coincide

approximately with each other, when plotted on the transformed axes. This fact confirms that time is correlated completely to concentration and temperature in regard to the distribution of resistibilities, namely, that time is related functionally to concentration and temperature.

3. As expected from the possibility of linear transformation of the temperature-mortality curve, the thermo-biokinetic equation of Bělehrádek is most applicable to the present cases, though the "biological zero" has been found to be located in extraordinarily high temperatures for water and kerosene emulsion.

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COMPETITION FOR FOOD AMONGST *Lucilia cuprina* LARVAE

By A. J. Nicholson

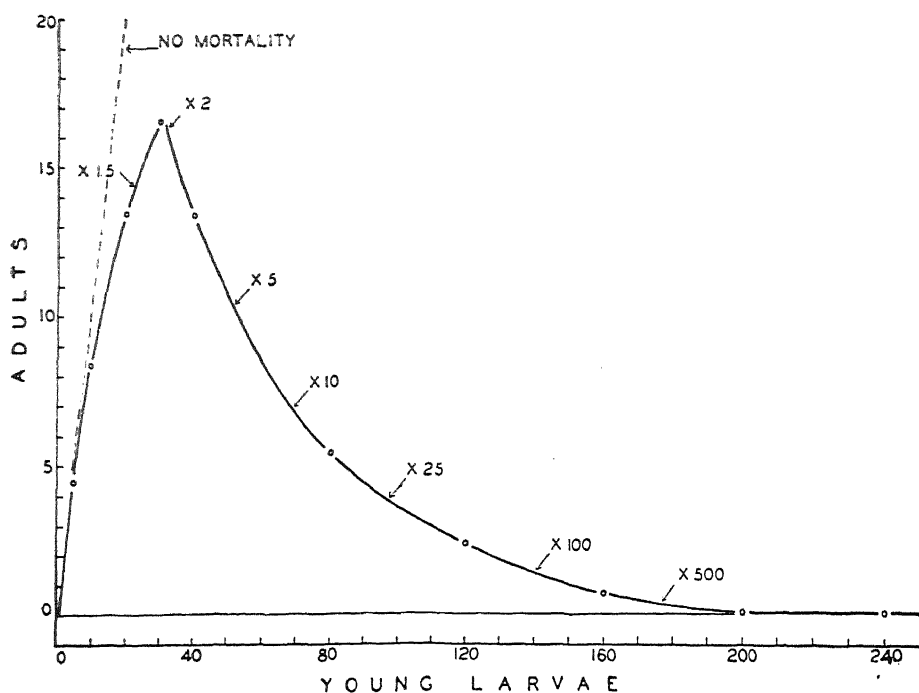
When organisms live in a constant environment and their populations are limited only by food that is supplied at a constant rate, it seems reasonable to expect that they will reach, and subsequently maintain, constant population levels. Experiments with certain organisms (e.g. *Tribolium confusum* (1) yeasts and protozoa (2)) held under constant conditions in the laboratory are consistent with this expectation; but recent experiments with *Lucilia cuprina*, and other muscoid Diptera, indicate that with these insects the population density generally fluctuates violently under constant conditions.

In the first series of experiments, the relationship between larval and adult densities was studied. A number of glass tubes, each containing one gramme of homogenized bullock's brain as food, were used, and in each of these a different number of freshly hatched *L. cuprina* larvae was placed. Such series of cultures were replicated many times. The number of emerging adults was then plotted against the number of larvae from which they had been derived. It was found that with progressively increasing densities of larvae, mortality at first increased only slowly, but the size of pupae and of adults fell progressively. However, this kind of compensation for increasing competition for food cannot continue indefinitely. A point was soon reached beyond which mortality increased rapidly with larval density and the number of adults produced per gramme of medium fell progressively with further increase in larval density.

These relations are shown clearly in the accompanying figure. In this particular example, eggs laid at intervals of two hours over an eight hour period were used, each of the five batches of eggs contributing equally to the numbers of larvae used in any one culture tube. A curve with the same general characteristics was obtained when there was no appreciable age distribution, all the eggs being laid within a period of one hour, the only important difference being that the descending part of the curve was much steeper.

The curve shows the relation between larval density and emergence of adults over the whole range of mortality due to competition for food, from nought to one hundred per cent. If, therefore, we know the power of increase of the adults (that is, the ratio of offspring to parents in the absence of competition effects), we can follow the population changes from generation to generation by using this curve. It is also clear that for every power of increase there is a point in the curve which represents a position of stability; that is to say a point at which mortality exactly counteracts the tendency to multiply. A number of such points are shown in the graph, the figure for the appropriate power of increase being preceded by the multiplication sign. Clearly if the larval or adult density initially corresponds to the position of stability, the densities of larvae and adults will remain unchanged in all subsequent generations in a constant environment.

Examination of the curve will show, however, that if the adults or larvae have any other density, oscillations in density will be generated, provided the position of stability is on the descending part of the curve. Thus if at the beginning the density of adults is higher than the steady value, the density of the larvae they produce will also be higher than their steady value (the power of increase remaining constant). The curve shows that this will lead to a density of adults in the next generation below the steady



value, and so on. Thus the densities of both adults and of larvae will be alternately above and below their steady values in successive generations, and there is no tendency to approach the steady values. It may be objected that in actual fact the power of increase does not remain constant; for adults derived from semistarved larvae are likely to produce less eggs than those from well fed larvae. This is true, but examination of the curve will show that this accentuates the tendency to oscillation instead of producing a damping effect.

By a similar process of reasoning it can be shown that if the point of stability lies on the ascending part of the curve, displacement of the density from this point will lead to an asymptotic approach to the steady density in subsequent generations. However, examination of the curve shows that this can happen only when the power of increase is very low, whereas with muscoid Diptera fecundity is normally high. Consequently with such insects oscillation in density should normally occur in a constant environment.

The above arguments apply strictly only when there is a succession of discrete generations. Overlapping of the generations may reduce the violence of the oscillations, but there is reason to believe that only in extreme situations can it prevent oscillation.

Cultures of *L. cuprina* are now being maintained under constant conditions, including a constant rate of food supply (50 gm. of meat per day), in order to determine whether oscillations do in fact occur in a constant environment. In these experiments there is complete overlapping of generations, the cultures having been established by adding a constant number of freshly emerged adults daily for a period exceeding the length of a generation. Clear cut oscillations that exhibit the anticipated characteristics have

been obtained, the period of oscillation being six weeks, and the maxima and minima of the adult populations being respectively about 2,500 and near zero.

Although at first sight it seems paradoxical that populations should oscillate in density in a constant environment when the only limitation is the availability of a constant food supply, the explanation is really very simple. There is nothing to prevent the growth of a population to the maximum numbers that can be supported by the available food. But when this point is reached the adults produce a large surplus of offspring, just as they did when their numbers were smaller, for the food becomes available first to the adults, and in any case their food requirements are small compared with those of the larvae. Consequently their offspring grossly overcrowd their food so that few, if any, reach the adult stage. In other words, there is an overshooting of the food supply which prevents the survival of offspring until such time as the adult population falls to a level at which larval overcrowding is not excessive. Then the cycle of multiplication, overshooting, and subsequent dying down begins again.

The above experimental results and arguments indicate that oscillation in density, and not the maintenance of a constant density, should be characteristic of animals that live in a constant environment and are limited by their food supply. Why, then, have other experimental populations studied not revealed such oscillations? Let us consider the examples already mentioned.

The protozoa and yeasts studied (2) multiply by fission, an individual dividing into two when it grows to a particular critical size. Starting with a low density of such microorganisms in a medium to which food is supplied at a constant rate, the organisms will grow and divide rapidly at first. Ultimately, however, the situation is reached in which the density of organisms is so high that food is consumed as fast as it is provided, and it is only just sufficient to maintain the activity of the organisms: the individuals do not grow and so do not multiply. Clearly the density will remain constant from then on.

The mechanism is different with *Tribolium confusum*. The active stages (larvae and adults) eat individuals of the inactive stages (eggs and pupae) that they meet in their wanderings. Consequently the percentage of inactive stages eaten progressively increases with increase in the density of the active stages. In a growing population, therefore, a point must ultimately be reached at which the percentage destroyed by cannibalism equals the percentage of offspring that is surplus. Further increase in density is clearly impossible, so this density is maintained as long as the conditions remain constant.

Thus internal mechanisms may prevent overshooting of the food supply and so prevent oscillation. The two described are by no means the only ones known, but they illustrate the two groups into which all such mechanisms fall, namely, those that prevent the production of surplus offspring, and those that ensure that the surplus produced is exactly destroyed, when the maximum density that can be supported by the food is reached.

The growth of *Drosophila melanogaster* populations, as described by Raymond Pearl (3), appears at first sight inconsistent with the results obtained with *Lucilia cuprina*. It must be noted, however, that for technical reasons Pearl's experiments always had to be concluded before the anticipated asymptotic population was reached, so he produced no direct experimental evidence that such populations do in fact reach and maintain constant population levels. The characteristics of *Drosophila* are

such that it should oscillate in density in a constant environment, and Pearl's experimental results are quite consistent with this expectation.

Although the most spectacular result of the experiments with *Lucilia cuprina* is the demonstration that populations limited by food alone in a constant environment may oscillate violently in density, other points of considerable interest are also revealed. Referring once more to the graph showing the relation between larval and adult density, it will be observed that when the powers of increase of the insects exceed about twice per generation, the steady densities of adults fall with increasing fecundity.

For example, when the power of increase is only twice per generation the steady density of adults is about fortyfive times as great as the density of otherwise similar insects with a power of increase of five hundred times per generation (the respective figures being 16 and 0.35 adults per gramme of medium). There is reason to believe that the average densities of the insects when their populations oscillate in density will correspond roughly with the values of their steady densities.

The accompanying graph also indicates that consistent density independent destruction of eggs, or of young larvae before they begin to compete, increases the steady densities of adults. For example if the natural power of increase is assumed to be 100 times per generation, and 90 per cent of all eggs laid are destroyed, the power of increase is reduced to a virtual value of 10 times per generation. The graph shows that in this example the steady density of adults is raised from 1.3 to 6.8. Preliminary results of the direct experiments already mentioned are consistent with this expectation: the average adult density in a culture in which 50 per cent of the very young larvae were destroyed being more than twice that in another culture in which there was no density independent destruction. On the other hand, 50 per cent destruction of pupae in another culture reduced the average adult density to nearly half. Thus, according to whether density independent destruction takes place before or after the time of density dependent reaction in the life cycle of the animal the density of adults is increased or decreased. This is in complete conformity with similar conclusions previously reached when making a theoretical examination of the interaction of hosts and parasites (4, 5, 6).

Thus it is seen that whether the density dependent factor that controls a population is availability of food or the action of natural enemies, there are certain circumstances under which the addition of a highly destructive density independent factor may lead to a great increase in the density of the insect. However, the situations studied, whether experimentally or theoretically, are very simple ones, much simpler than those generally to be found under natural conditions; and it is known that there are other factors, not mentioned in the present discussion, that may reduce the effects described. Consequently one cannot state with certainty that the use of a destructive density independent factor, such as an insecticide, must in some situations lead to a great increase in the density of a pest; but that possibility is quite definite. It is clear from the results already obtained, however, that we must be very suspicious of the widely held belief that the mere killing of high percentages of pests will necessarily reduce their abundance, and so lessen the damage they cause.

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## THE USE OF VITAL STAINING METHODS IN INSECT HISTOLOGY RESEARCH

*By Nils-Bertil Palm*

Vital staining, or the subjection of living tissues to dye-stuffs, is a method of histological and physiological research which has become widely appreciated in various fields of these sciences. Hitherto chiefly vertebrate material, especially mammalian, has been investigated with this method, but fundamental investigations have also been carried out on invertebrate material. Several important works deal with the elective or discriminating vital staining of various organs in crustacean arthropods. As yet the vital staining methods have not, however, been used in insect histology or physiology research to any more important extent, and yet these methods appear to be extremely valuable, not only as offering interesting results with regard to the reactions of the body to the dye-stuffs, but also as a technical aid to other work on insect physiology or morphology. The object of this lecture is chiefly to point out the possibilities which are opened up by the vital staining methods, and to give some technical hints to those who find that their results may become improved by the adding of the vital staining to their methods of work.

A general orientation of the vital staining is probably motivated. There are two important methods: vital staining proper, and supravital staining. In the former case the dye is introduced into the organism either by the injection of a dye solution, or through the breeding of the animals on a dyed substrate, or by adding the dye to the surrounding medium—the latter is only possible when dealing with aquatic animals. The dye-stuff is then resorbed by various tissues of the body. When the staining is supravital, the dye is added to the physiological saline solution in which excised organs are kept; after a period of five to thirty minutes the dye has been absorbed by certain tissue elements. In all work of this kind it is extremely important that a Ringer's solution exactly fitted for the animal in question is used. Otherwise there is a great risk that cell injuries occur, which are more damaging to the results than the slow decrease in tissue vitality which always appears in isolated organs. Tissue cultures from insect material are, as a rule, very difficult to obtain.

The examination of the vitally stained material follows in a pure Ringer's solution. Usually it is impossible to fix, embed, and section the vitally stained tissues without dissolving the stain; the most important exception is the trypan blue staining, which may be beautifully fixed in the Susa mixture.

With regard to the appearance of the stained material, two general types of vital staining may be distinguished between: elective or discriminating vital staining, and non-elective vital staining. In the first case only a certain organ, or a certain organ system, is stained, while in the second case the dye is more evenly distributed in the various parts of the body. The true elective vital staining is hardly known from insect material, with the possible exceptions of the methylene blue nerve staining and the staining of connective tissue and physiologically similar tissues with trypan blue. The latter exception will be mentioned again later, and refers to hitherto unpublished results of my own. A non-elective vital or supravital staining of insects is, however, easily effected, and it may be mentioned that the resorption of the dye in the different organs varies according to the concentration of the dye solution used.

Due to the fact that certain tissues are readily stained even with a very dilute solution, it is possible to bring these tissues in contrast to the surrounding elements.

A large number of dye-stuffs may be used for vital staining, but most of them are not very interesting with regard to insect study. Certain dyes are best used for so-called direct vital staining, that is, the dye is added to the medium in which the animals live—usually water, and therefore this method is not very handy in insect study. According to their electrical charge the dye-stuffs are divided into acid, neutral, and basic stuffs. Of the acid dyes, the azo-compounds trypan blue and Congo red are the most profitable, used for injections. The neutral dyes are not very suitable for insect study, while the following basic ones yield interesting results after injection or supravital staining: neutral red, and methylene blue. The basic dye Janus green, which should be used for supravital staining only, must, if the results shall be correct, be pure diethylsafranin-azo-dimethylanilin or the chloride of this substance, the commercial Janus green B.—The acid dyes mentioned above are colloidal and not very diffusible; diffusible dyes as eosine cannot be used for proper vital staining, as they enter all cells quite indiscriminately, staining all of the cytoplasm diffusely. Most vital dyes are stored in the cytoplasm in the shape of granules of various sizes. The nuclei are normally not stained by these dyes, and thus the typical vital staining may be used as a criterion of the vitality of the cells. During the influence of anesthetics or oxygen deficiency a nuclear staining may occur, but this staining is reversible, while the nuclear staining occurring *post mortem* is irreversible.

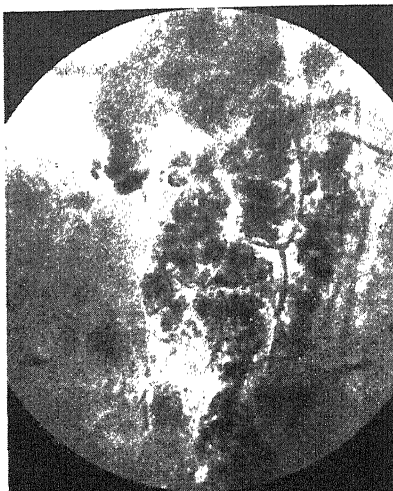
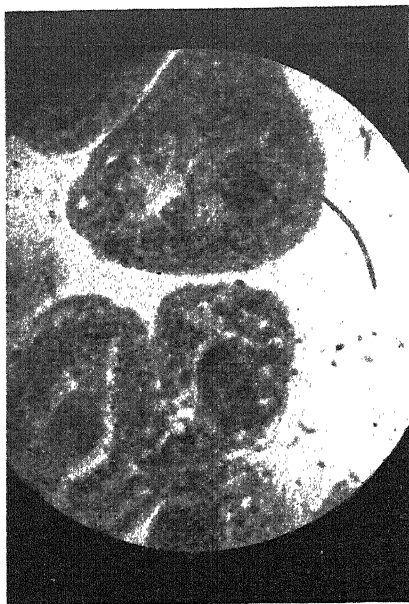
#### *Applications of the Vital Staining Methods*

By means of studying the resorption of various dyes by the different tissues one is able to gather information about the physiological properties of the tissue cells. Certain cells show a high degree of resorptive activity, others do not. The mechanics of the vital staining are as yet not fully understood—there are many phenomena which are not explained by the physico-chemical laws as they are known now. The physico-chemical properties of dye-stuffs or cell membranes do not explain the differences occurring between various tissues, nor the fact that some dyes are resorbed by a certain tissue, while other, similar dyes, are not resorbed by the same tissue.—The more important ways of utilizing the vital staining methods are briefly dealt with below.

##### *1. Vital staining as an aid in morphological work*

In many cases it is necessary for the investigator to be able to *see* the small organs with which he is working. This may prove awkward or impossible at ordinary dissection under the binocular, but if the organs in question are properly stained they brightly contrast to the surrounding tissue, and this obviously facilitates delicate morphological or physiological work. The connective tissue and the pericardial cells may easily be demonstrated by the injection of trypan blue, and the tissues may be fixed and studied in balsam-mounted sections—a later counterstain, for instance with neutral red or safranin, is possible on the sections. Figure 1 is a microphotograph of a preparation made in this way: it shows the pericardial cells of an *Amphimallon* larva, vitally stained with trypan blue, fixed in Susa, sectioned, and counterstained with neutral red. The dark dots are the dye granules. A colour photograph would have done better, but I regret to say that I have not been able to take any such. In figure 2 the pericardial cells of the small beetle, *Tribolium destructor*, are seen, vitally stained with neutral red, and photographed as surviving tissue, at a rather high magnification.

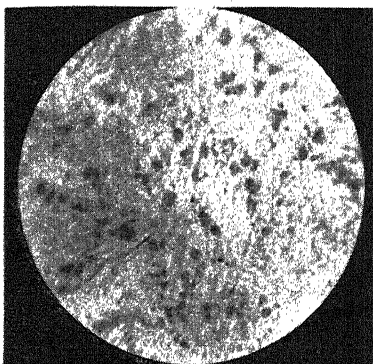
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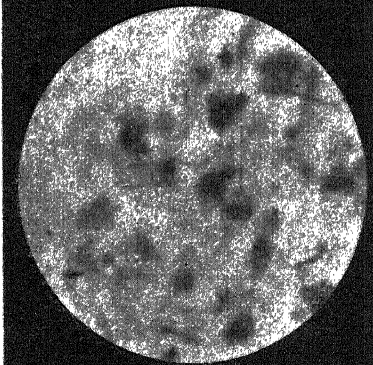


Fig. 1. *Amphimallon solstitialis*, larva. Pericardial cells, vitally stained with trypan blue, fixed in Susa. Sections counterstained with neutral red.

Fig. 2. *Tribolium destructor* ♂, pericardial cells, vitally stained with neutral red. Living tissue.

Fig. 3. *Tribolium destructor* ♂, corpora allata and corpora cardiaca, supravitaly stained with neutral red. Surviving organs.

Fig. 4. *Bombus terrestris*, worker, connective tissue coat from the poison gland, supravitaly stained with neutral red. Living tissue.

Fig. 5. A part of the same preparation as in fig. 4, at a higher magnification.

The vital staining of the nervous system with methylene blue is well-known, but does not, as a rule, succeed in demonstrating the finest nerve branches or nerve endings in insect material. The correct staining is, by the way, rather complicated, and as the exact procedure must be found out for each species it becomes rather tedious.

For the demonstration of various organs, as glands, the supravital staining is, however, to be recommended, as it is much more simple. Delicate muscular networks, as found around the genitalia, may be beautifully demonstrated by a supravital staining with Janus green B, used as a relatively concentrated solution in a Ringer's (about 1 to 5000). Small organs of epithelial nature may be clearly visible after supravital staining with a diluted solution of neutral red in saline (the dye is precipitated in a normal Ringer's solution). The concentration must be found out in each case. The corpora allata of most insects, for instance, are quickly stained by a solution holding 1 to 20,000 of neutral red, while the neighbouring brain tissue and tracheae remain unstained. The supravital stained corpora allata of a male *Tribolium destructor* are seen in figure 3, beautifully contrasting to the corpora cardiaca and the other tissues in the preparation (treated with neutral red).

## 2. *Vital dyes as indicators*

Most of the dyes used for indicating hydrogen ion activity or reduction-oxidation potential cannot be applied as vital dyes. By the use of the micro-injection technique, some of them may give information on the intracellular conditions, but the results are often questionable, as several sources of errors are present. A list of the dyes which may be used is given by Ries in his "Grundriss der Histophysiologie" (1938).

Injections of basic vital dyes may cause a staining of the cell nuclei, as already mentioned, and this may be due to a reduced oxygen supply. Alexandrov (1932) thus found such a nuclear staining normally occurring in certain aquatic Dipteran larvae, living in a medium very poor in oxygen. This nuclear staining is reversible.

The usual methylene blue method used in respiration investigations is not a vital staining.

## 3. *Investigations on the protective organs of the body*

By the injection of colloidal solutions with a convenient micellar size, as for instance trypan blue or Congo red, certain protective organs of the body are revealed. These organs form a system which may be compared with the reticulo-endothelial system of the vertebrates (or the RE-system), and which in these animals, too, is best demonstrated by intra vitam staining with trypan blue. These elements are of connective tissue nature: connective tissue cells surrounding various organs, pericardial cells, cells of the fat-body, and certain blood cells. Most cells of the body are not stained by trypan blue, unless strong doses are injected repeatedly, in which case, however, the dye is apt to produce toxic symptoms. When the dye has become resorbed by the tissues it is not eliminated. Trypan blue is not eliminated by the Malpighian tubes, but as a rule they become red. This is due to the invariable presence of a red, diffusible contamination of the dye-stuff.

The protective elements react in the same way for most foreign bodies in the blood of a convenient size, as for instance a suspension like indian ink.—The trypan blue staining is shown by Figures 1 and 2; neutral red supravital staining of protective organs is shown by Figures 4, 5, and 6.

#### 4. *Investigations on the excretion*

The elimination of various substances by the Malpighian tubes is easily seen when dyes are injected. The tubes may appear stained, but generally no true vital staining occurs, that is, the dye is not stored in the cells in a granular form: it is rapidly passed on to the lumen. Quantitative investigation on the rate and efficiency of the excretion may be made by estimating the time required for the complete elimination from the body of a certain injected amount of dye. Qualitative investigation on the manner of the excretion may be made supravivally.

Exhaustive studies on the excretion of a very large number of various dyes have been made by Lison (1937).

#### 5. *Investigations on the resorption in the digestive tract*

The resorptive power of the alimentary organs under various conditions may be tested by feeding the animals dyed food-stuffs. Neutral red or trypan blue may be used. After the lapse of a certain time the body is examined, and it is noted where the dye has been resorbed, or if it has passed through the gut without being resorbed. The eliminating activity of the Malpighian tubes must, of course, be taken into consideration in these cases. By these means it is also possible to find out if an animal really does eat the offered food, or if it is able to utilize it.—The breeding of larvae on dyed substrate may give opportunities of examining the ultimate fate of various organs during the metamorphosis.

#### 6. *Permeability examination*

The greatest care is recommended when the permeability of cell membranes is judged from the reactions to vital dyes. The circumstance that a certain dye is not resorbed by a certain tissue, *does not* imply that the tissue membrane in question is impermeable to substances having a certain micellar size. The reasons for the differences in reaction to various dyes are not, as already mentioned, understood.

The differences in physiological properties of growing tissues of various ages may, however, be safely judged from their vital staining reactions, if the same dye is used for the various tests. An interesting example is shown by the Figures 7 and 8, which are photograph of neutral red supravivally stained ovarioles of a butterfly, the Green-veined White (*Pieris napi*). In fig. 7 very young egg-chambers with their adjoining nurse-chambers are seen. The nurse cells are not stained, while the follicular epithelium and the periphery of the egg cells are stained. In fig. 8 older eggs are shown (the magnification is much lower!); the eggs are stained brightly red, vividly contrasting to the unstained nurse follicles. The egg cells are here in a stage of rapid growth, and the permeability of the egg membrane is greatly increased.

#### 7. *The properties of glandular tissues*

Injected neutral red is granularly stored by epithelial cells, and if the technique is correct, the granules correspond to vacuoles normally occurring in the cytoplasm—these vacuoles are therefore often called neutral red vacuoles. The size and distribution of the vacuoles varies with the different secretion phases of glandular cells. Secretion granules are not stained. This staining may also be made supravivally, but either a simple solution of sodium chloride must be used instead of the usual Ringer's solution, or the dyed Ringer's solution must be quite new and only used for a few minutes, as the neutral red soon precipitates, forming small needles which adhere to the tissues and disturb the picture.—The neutral red staining of cells from a pharyngeal gland

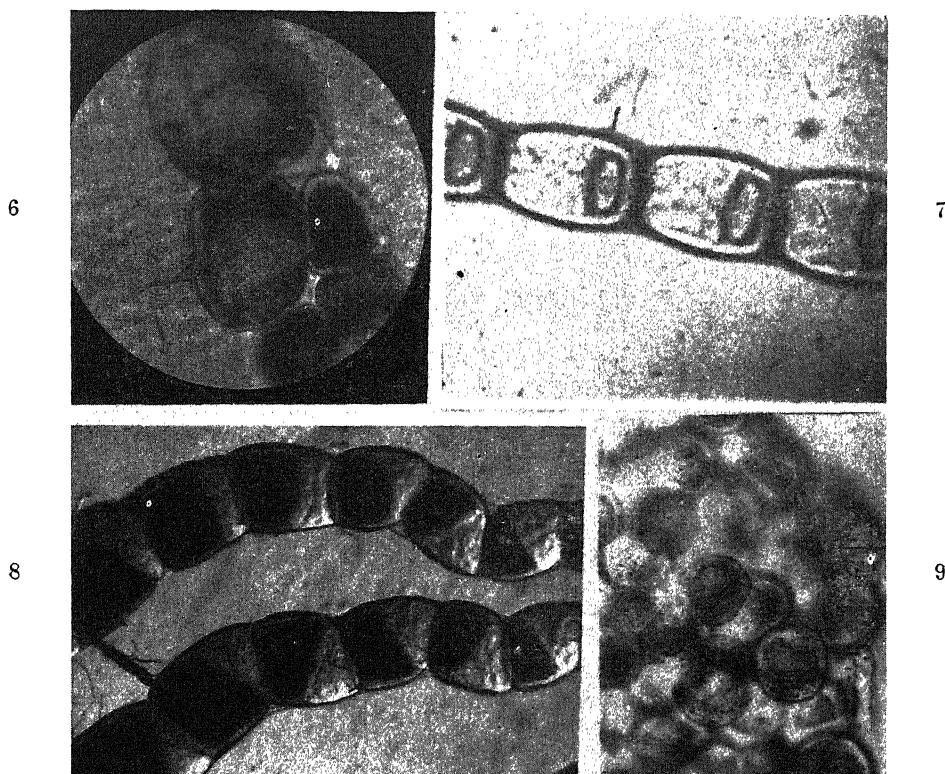


Fig. 6. *Bombus lapidarius*, ♀, pericardial cells and alary muscles, supravitaly stained with neutral red. Living tissue.

Fig. 7. *Pieris napi* ♀, part of an ovariole, supravitaly stained with neutral red. Living tissue.

Fig. 8. The same preparation as in fig. 7, but showing older eggs. Magnification lower. Living tissue.

Fig. 9. Cells from a pharyngeal gland of *Bombus lapidarius*, worker, supravitaly stained with neutral red. Living tissue.

of a bumble-bee is shown in fig. 9. The cells are resting, filled with stored secretion granules, and therefore the neutral red vacuoles are small and few.

Mitochondria may be stained supravitaly by a diluted solution of Janus green B, and their variations during the functionary phases may be studied. However, the method is not as safe with insect material as with vertebrate tissues, as other elements too may become stained. If the dye solution is but slightly more concentrated, a granular storage of the dye-stuff appears, similar to that usually occurring when other basic dyes are used, and in an even more concentrated solution muscles are beautifully stained.

In vertebrate cells the Golgi apparatus is stained by trypan blue, but I have not found anything indicating a similar condition in insect tissues.

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Finally it may be mentioned that it is possible to make a double-staining vitally, that is, two or even more dyes may be used on the same animal. For instance, a vital staining with trypan blue may be succeeded by a staining with neutral red. The results become, however, confused, and they do not appear to be very interesting. A simultaneous staining of neutral red vacuoles and mitochondria might prove interesting, but as yet I have been unable to succeed with this combination on insect tissues.

Chemical information on the vital dyes may be found in "Biological Stains" by Conn, 1946.

Some discussion on the use of vital stains has recently been published. To what extent these modern applications hold true for insect tissues has not, however, been investigated as yet.

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PARASITE ACTION ON *Bombus* QUEENS

By Nils-Bertil Palm

When speaking of parasite action on *Bombus* I especially refer to the effects of the Nematod parasite, *Sphaerularia bombi* Dufour, a worm that was for the first time mentioned from the Scandinavian countries by me in 1945, and which has proved to be extremely common in Southern Sweden. The fertilized females of the worm enter the bumble-bee queens when these burrow themselves in the autumn in order to hibernate. During the winter a peculiar development of the worms takes place: its genitalia show an enormous growth, and a large, wormlike genital appendix, 20 to 30 millimeters of length is formed, representing a kind of uterus.

When the bumble-bees re-emerge in the spring, they show no outward signs of parasitic injury. Later in the spring certain differences in the behaviour may be found between the parasitized and non-parasitized queens. The latter fly around for a time, visiting flowers and collecting pollen and nectar, and then they disappear: the new litter has pupated, and soon the workers emerge. After this the normal queens do not appear above earth. The parasitized queens, however, continue to fly about restlessly, even as late as in July, due to the fact that they do not found any new colonies. This disturbance of the reproduction indicates that internal injuries have been caused by the parasite, a phenomenon which appears to be rather natural with regard to the large size of the worm's genital appendix, and the circumstance that a large number of worms may be present in one bumble-bee queen. The causes of the disturbances appear, however, to be rather more complicated.

When the bumble-bees are opened it becomes evident that the ovaries are very small and thin, even in the later periods of the spring, while they in the non-parasitized females grow very considerably. The ovaries of the parasitized females look rather similar to those of the small workers. A histological examination shows, however, not only an arrest of development, but a distinct degeneration of the various elements of the ovaries.

First of all the egg cells degenerate and become resorbed by the surrounding follicular epithelium; this epithelium is then transformed into a structure rather similar to that of the so-called corpus luteum of normal ovaries. Later on, the nurse cells, too, disintegrate, and become resorbed. In some cases the disturbance of the egg growth does not begin until very late in the egg development, that is, the chorion has already been formed. When the egg then is resorbed and the chorion is broken up, it appears as if different epithelial cells from the follicle epithelium are active at the resorption than at the chorion formation. Also in normal ovaries I have found it reasonable to assume that the cells engaged in the chorion production are more or less differentiated from those forming the yolk.—Egg cell degeneration is shown by figure 1 (occurring in an otherwise normal ovary).

Late in the spring, innumerable young worms hatch within the host's body, swarming around and penetrating into various organs. Very often these nematod larvae enter the ovaries and the oviducts of the bumble-bees, and then they produce more or less conspicuous mechanical injuries: the tissues are partly dissolved, as shown by the figure 2. These injuries, however, may be quite disregarded in the discussion of the action of the parasites, as they appear too late to have any importance: the chief damage is already done, and the reproduction of the queens is checked.

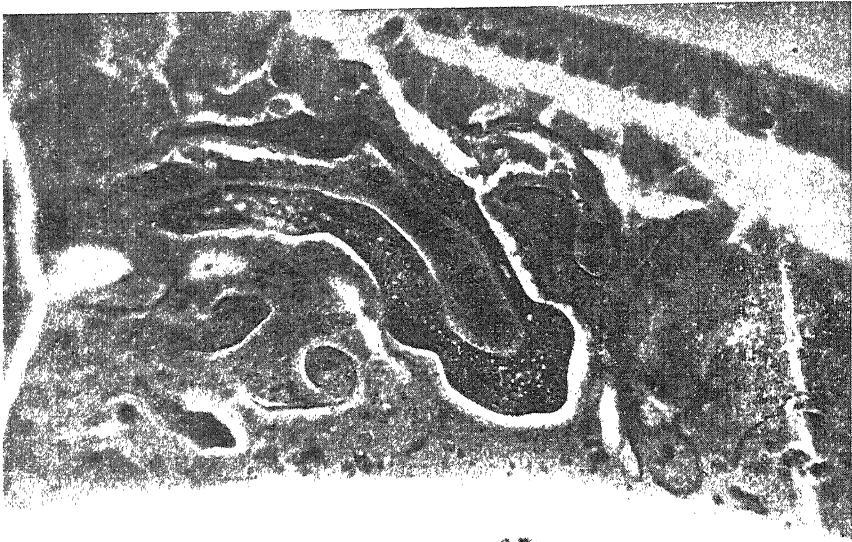


Fig. 1. Oocyte degeneration occurring in an ovary from a normal *Bombus terrestris*. The disintegration of the egg has set in after the chorion formation. (Palm 1948.)

The changes appearing as results of the parasitization are not, however, restricted to the parasitic castration. A close examination of the corpora allata has shown that these too become arrested in their development. When the size of the corpora allata is measured, a significant difference appears between the glands from parasitized and non-parasitized bumble-bee queens: those from the parasitized ones are considerably smaller. As I have found that the corpora allata of the queens, before their retiring to their winter quarters, normally are smaller than after the hibernation, even immediately after emerging in the spring, I have ventured the opinion that a growth of these organs takes place during the hibernation. This growth is inhibited in the parasitized females. Histological changes, however, are not very distinct—sometimes the corpora allata of the infected queens show disturbances, but as often they do not.

A rather interesting problem is the question of the true nature of the effects caused by the parasitization. The effects are generally held to be due to a starvation of the host, caused by the removal of considerable amounts of necessary material from the body fluids. This may be quite true in most cases, and it is also a well-known fact that starvation prevents the development of the ovaries in several insects. Yet I am inclined to believe that the starvation is of minor importance in the case of the *Sphaerularia* effect on *Bombus*. I find it more consistent with the actual findings that the worm is a true pathogen organism, discharging some toxic substance which is responsible for most of the disturbances occurring in the parasitized females. My reasons for this opinion are the following: An examination of the fat-bodies of parasitized and non-parasitized queens has shown that no appreciable differences in size and fat content occur; the protein quantity in the fat-body also appears to be about the same. During the hibernation a reduction of the fat-body normally takes place.

but this is the same in both cases.—The parasite's effect on the host's ovaries was the same whether a large number of parasites were present, or if only one single worm was found. When it is conceivable that an all-or-nothing law may apply to this case if toxic substances are involved, it is more difficult to visualize such a condition if a starvation effect is assumed.—The growth of the genital appendix of the parasite takes place during the winter, but the ovaries do not commence their egg-production until after the re-emergence in the spring. And during this period there does not appear to be any difficulties for the bumble-bees to collect ample quantities of food.—The castration is complete even in those cases where the host has been able to destroy the parasites, so that only small, dead worms are found in the host's body in the spring. And these small worms cannot have deprived the host of much food.



Fig. 2. Young *Sphaerularia* in the calyx of a *Bombus terrestris* ovary.  
(Palm 1948.)

For several insects a connection between the corpora allata and the reproductive organs has been established: the corpora allata produce a hormone, which is necessary for the normal development of the ovaries. That such a relation exists in bees has not been experimentally proved, but there are no reasons to doubt that so is the case. In fact, the study of the normal histology of ovaries and corpora allata indicates this, and certain pathological disturbances in the corpora allata, which I have encountered, were followed by abnormalities in the ovarian development. For instance, an infiltration of the corpora allata with connective tissue is connected with an inhibited growth of the ovaries.

The arrested growth of the corpora allata in the *Sphaerularia*-infected queens is fully developed already before the time for the re-emergence in the spring, and therefore it may be rather safely concluded that this deficiency of the glands is connected with the ovaries' failure in developing. Especially as the signs of secretion seen in the

epithelial tissue of the corpora allata are more indistinct in the parasitized females, it appears evident that these animals are deficient in the gonadotropic hormone, and my conclusion is that this is the direct cause of the arrest of ovarian development, while the disturbances of the corpora allata are the primary effect of the parasitation. The somewhat debated character of the corpora allata hormone: if it is a true gonadotropic hormone, or a metabolism controlling hormone, does not influence this theory.

Summarily it may be said that according to my opinion the parasite effects on *Bombus* queens parasitized by the nematod, *Sphaerularia bombi*, are due to a disturbance in the hormone production from the corpora allata, caused by the discharge of toxic products by the parasite. The lack of corpora allata hormone causes the parasitic castration, and thus this is a secondary effect of the parasitation.

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## PERISTALTIC MOVEMENTS OF THE MALPIGHIAN TUBES

By *Nils-Bertil Palm*

When the abdomen of an insect is cut open, it is in very many cases easily seen how the Malpighian tubes, or part of them, perform more or less vigorous movements of various types. It is also easy to find out that this peristalsis is normally occurring in the intact insect body, as several beetles, for instance, have a transparent dorsal tegument, through which the tubes can be held under observation for a considerable time, after the removal of the wings. The peristalsis may furthermore be studied in surviving tubes, placed in a properly adjusted physiological saline solution, preferably a modified Ringer's solution. The gut, with the Malpighian tubes, is excised and submerged in the saline, and the peristaltic movements continue, sometimes for more than 24 hours. The tubes may then be closely studied under the binocular or under an ordinary microscope. Even Malpighian tubes that have been cut off from the gut continue their movements for quite a respectable period.

It lies near at hand to suppose that the movements are caused by the contractions of muscular elements, but often it proves difficult to demonstrate any muscles around the tubes in histological sections. After a close examination of a number of insect species, representing several orders, I have, however, been able to detect muscle fibres in all the cases where movements were found to occur in the tubes. Sometimes special methods for the demonstration of muscles were necessary, in some cases involving a poor technical quality of the other tissue elements in the sections.—According to their muscular supply, the Malpighian tubes of the investigated insects may be divided into four groups.

*Type 1.*

Muscular elements absent. Found in Thysanura, Dermaptera, and Thysanoptera. The Malpighian tubes of the examined species belonging to these orders did not show any peristaltic movements.

*Type 2.*

Muscle fibres are found around the opening of the tubes into the gut, and usually also on a short part immediately adjoining the opening. This type is found in Hemiptera, Trichoptera, Lepidoptera, and Diptera.

The Malpighian tubes belonging to this category do not themselves possess any muscles—the fibres mentioned above originate with the muscular coats of the gut. The tubes do not perform any movements with the exception of the proximal part, which shows rhythmical contractions, as well as the orifice, which shuts and opens more or less regularly. The muscular activity in this case is dependent on the excretory activity of the tubes, that is, it is related to the amount of excreta passed from the tubes onto the gut.—An arrangement of rather strong muscle fibres is often found around the proximal part of the tubes, even if they possess muscles of their own, and thus rightly belong to the two latter categories. This muscular coat around the opening part of the tubes originates with the muscles of the gut, and is especially well-developed in those cases where the individual tubes open into a common bladder.

The bladder has a rather conspicuous muscular coat, and its peristalsis shows a rhythm of its own, portioning out the excreta into the gut.

*Type 3.*

The Malpighian tubes belonging to the third type possess long muscle bands running along the tubes, usually winding round the tube to form a spiral. In Orthoptera and Odonata strong muscular bands are found, which are easily seen under the binocular, while more delicate bands are found in certain Hymenoptera. The number of the long muscles is somewhat varying. Thus we find only two parallel bands in grasshoppers, while six bands occur in some Hymenoptera (for example, in the honey-bee, as reported by Morison 1928). The muscles are very distinctly cross-striated, which may be seen under the microscope without any staining.

The Malpighian tubes of the Orthoptera show a violent peristalsis: rapid corkscrew-like windings and unwindings, and at the same time pulsations of the individual parts of a tube. Progressing contraction waves do not occur.

The conditions in Phasmida and Mantodea appear to be quite similar to those in Orthoptera.

The features of the Malpighian tubes of a grasshopper in contracted and relaxed state are shown by the figures 1, 2, and 3.

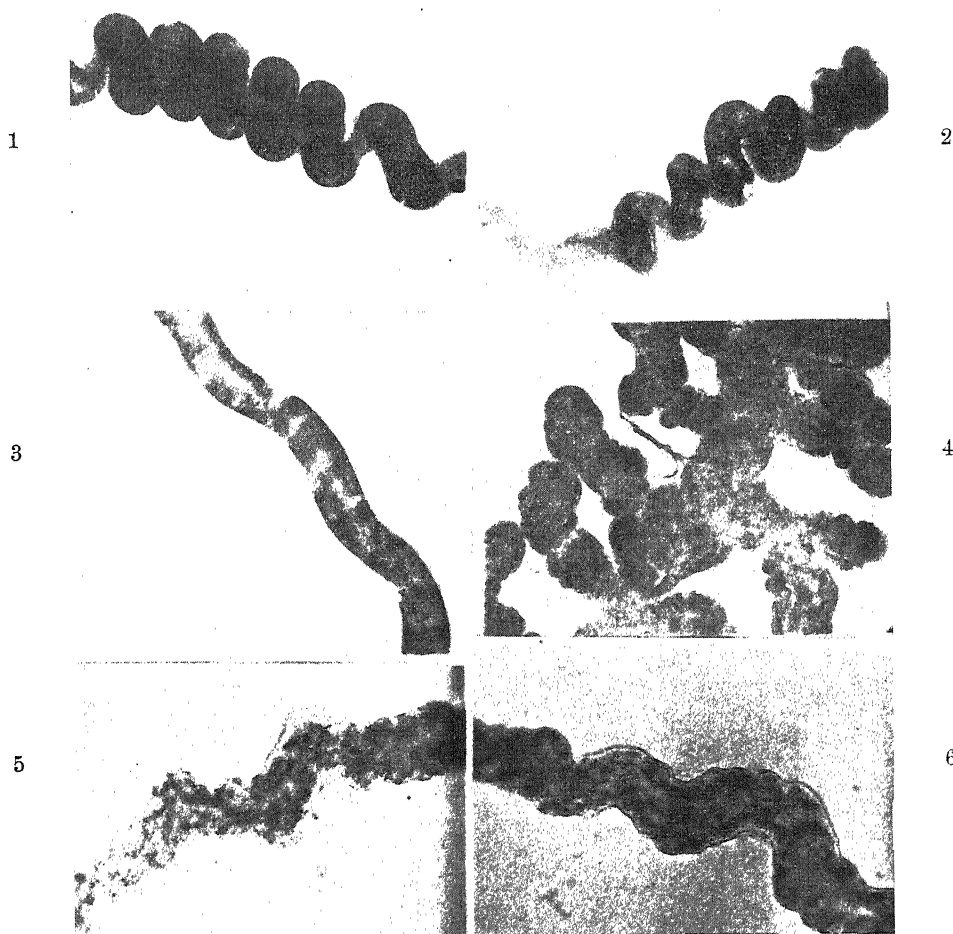
*Type 4.*

A more or less strongly developed reticulum of fine muscular fibres is present around the tubes. Occurs in Neuroptera and Coleoptera. The winding movements of the tubes are rather weak, but local rhythmic contractions are rather strong and pronounced, yet they are, as a rule, not very rapid. Progressive contraction waves do not occur—indeed, such a type of peristalsis is found only in very few, exceptional cases, in insects which cannot be correctly placed in either of these four groups.

The rhythm of the contractions is in most cases rather regular, but variations occur, due to the physiological state of the tubes. Irregularities are apt to appear immediately after the excision of the organs, and may be provoked by pharmacological action. In *Stenobothrus* 60 contractions per minute may be found, but the normal rate is somewhat smaller. In *Chrysopa* 30 contractions per minute is a normal rate, and in *Amphimallon* an average of 20 contractions per minute is found.—The Malpighian tubes in *Amphimallon* (as well as in related beetles) show a rather peculiar development: they possess lateral branches, forming something like a herring-bone pattern, as seen by the figure 4. In a great many beetles the Malpighian tubes show what is known as a cryptonephridial arrangement. These peculiarities cannot, however, be dealt with here. The tubes show the usual peristalsis and muscular arrangement of Type 4 in these cases.

All the contractions are not total: usually weak and maximal contractions alternate. When the contraction is maximal the lumen is quite obliterated. Different degrees of contraction are seen in the figures 5 and 6 of *Agelastica* Malpighian tubes.

I have not been able to find any response to electrical irritation of the tubes. On the other hand, pharmacological muscular stimulants, as acetylcholine and veratrine, produce a marked effect: the contractions become slower but much more total, indicating an increase of the efficiency of work. Nerve paralyzing drugs, as curare, cocaine, and the DDT-preparations, do not produce any noticeable effects on the peristalsis. When the tubes are stimulated to an increased excretory activity, as may be done by the injection of a dye-stuff, the peristalsis becomes slightly increased in activity.



Figs. 1—6. Fig. 1: Malpighian tube of *Stenobothrus*, contracted. Fig. 2: The same tube, partly dilated. Fig. 3: The same tube, completely relaxed after veratrine poisoning. Fig. 4: Part of a Malpighian tube from *Amphimallon solstitialis*. Fig. 5: Part of a Malpighian tube from *Agelastica alni*, contracted. Fig. 6: The same tube, partly relaxed. (Figs. 1—3 from Palm 1946.)

Several factors indicate that the muscles of the Malpighian tubes form an automatic system. It has proved impossible to demonstrate any nerve fibres ending on the tubes, and the peristalsis is not noticeably influenced by the action of nerve paralyzing drugs. The movements continue undisturbed when the tubes are cut off from the gut, and may continue even if they are cut into quite small pieces. It seems rather probable that the muscular net-work, or the muscle bands, form an impulse-conducting system of their own, similar to that of the vertebrate heart. Some experiments were carried out on the Malpighian tubes of *Stenobothrus*. With the aid of the micromanipulator a fine

glass needle was introduced into the nucleus of a part of a muscle band, and the effect was an immediate inhibition of the movements of the part in question. A puncture in the cytoplasm had very inconsiderable effect. The muscular bands of these tubes are syncytious and run along the whole of the tube with nuclei at regular intervals.—The muscles of the Malpighian tubes are probably stimulated to contractions by chemical irritation originating with the surrounding blood, and by irritation from the contents of the tubes. Thus the peristaltic activity is determined by the excretory function of the epithelium.

#### *Significance of the peristalsis*

The obvious reason for the peristaltic movements of the Malpighian tubes is that the contents of the lumen are to be brought forward, in direction towards the gut. That such a direct transportation is necessary appears evident in those cases where the contents of the tubes is partly crystallized; when the urine is quite fluid it may appear to be superfluous. An observation of the transport of the contents of the tubes in a Ringer's solution shows, however, that the same portion of excreted matter is brought forwards and backwards several times, that is, an *antiperistalsis* occurs regularly. This is of course inconsistent with the theory that the peristalsis is propulsatory only. A consideration of the excretion mechanism throws some light on this question. The urine excreted into the distal parts of the tubes is watery and quite fluid, while the contents of the proximal parts is more or less rich in dry material, as crystals. This indicates that a reabsorption of water occurs in the proximal, lower parts of the tubes, and it would seem reasonable to assume that the reabsorption is facilitated by the antiperistalsis, as this causes the contents of the lumen to come into contact with the epithelial walls of the tubes more closely. This theory is supported by the observation that the violent excretion of a watery urine occurring in a hypotonic saline solution is not accompanied by any antiperistalsis—in fact, the peristalsis is almost immediately checked. Furthermore it has been noticed that no antiperistalsis appears in the Malpighian tubes of aquatic insect larvae, and that all the peristalsis of the tubes is decreased when the air humidity is increased.

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## SOME DETAILS AND THEORIES OF THE PROBLEM OF THE FLIGHT OF INSECTS

By *Olavi Sotavalta*

The principal results which I have obtained in my research work on insect flight have been published earlier (Sotavalta 1947).

One of these results may be worth mentioning also in this connection. Already at a very early stage of this research work, a question occurred, whether the wingstroke frequency possibly could have any exact relation to the morphological characteristics of the insect. It is known of old that e.g., the lepidopterous and crane fly types have a low wing-stroke frequency (less than 80), the coleopterous, hemipterous, hymenopterous, and fly types a medium (60—250), and mosquito, gnat, and midge types a high wing-stroke frequency (200—1000 strokes per second). To solve this problem many methods were tried which were aimed at probability calculation. A simple mathematical exponent equation was constructed—because equations of other kinds were not found satisfactory. First, random samples were taken by solving the following equation

$$f = k \cdot a^x b^y c^z$$

( $a$ , weight of the insect,  $b$ , its wing length,  $c$ , its stroke-angle,  $f$ , its wing-stroke frequency,  $k$ , a constant)

in regard to very heterogeneous cases chosen out of the material and corresponding to the number of unknown factors in the equation. Agreement of the results was already rather astonishing. The method of least squares was now used for solving the question, and the result obtained by this method which satisfactorily agreed with the random samples mentioned above, showed approximately the following values:

$$f = k \cdot a^{0.3} b^{-1.3} c^{-0.75}.$$

In contrast to this “empirical” deduction, building the deduction on purely physical laws and conditions which appear in connection with the striking of a wing, Attila (1947) comes to a corresponding equation which has the form as follows (the symbols parallelized with the equation above):

$$f = k \cdot a^{0.25} M^{-0.25} c^{-0.75}.$$

$M$  is a surface moment of the wing which is to be calculated by a certain integration of the wing surface. Now it was found that in all insects, independently of the form of the wing, the value of  $M$  is equal to  $const \cdot b^5$ , so that we can replace  $M^{-0.25}$  with  $b^{(5/-0.25)} = b^{-1.25}$ . This means that all insect wings have an appropriate form which is in its effect proportional with each other one. Now we also see the agreement of the exponents of these two equations, which further testifies to the appropriateness of nature.

It is very probable that  $k$  of the first equation involves a factor dependent on the wing mass, i.e., physically speaking, its moment of inertia, which to some extent can be

considered as a function of the area of the wings, or the total carrying area of the insect. We can replace  $k$  with a new factor which is found to be most appropriate.

This is to be named "relative sustaining capacity" ( $s = \frac{\text{total area}}{a^{2/3}}$ ), and we can add it to our equation ( $s^{-0.78}$ ). Of course we obtain a new constant  $r$ . I have not yet had an opportunity to examine to what extent this factor  $s$  is definite. But, calculating the value of  $r$  on the basis of the factors of the equation, I have obtained, taking the basic dimensions in  $mg$ ,  $mm$ ,  $mm^2$ , angle degrees ( $^\circ$ ), and  $sec.$ ,  $\log r = 5.10 \pm 0.08$  in respect of a very heterogeneous material of 65 cases.

Another interesting problem in the field of insect flight is the form of the wing-stroke. For eighty years it has been known, and, for 120 years, assumed that the wing does not strike merely down and up, but makes certain torsions. In the Figure 1 we have an insect projected on a vertical-sagittal plane, and we assume that the wings in normal flight strike exactly symmetrically, so that every force component that arises that has its direction perpendicular to this plane is annulled by a corresponding one in the opposite direction. Moreover, in this connection we describe the forces from the viewpoint of the insect, and not as a phenomenon in space. As fact No. 1 we know that the stroke direction always is somewhere between the vertical and the backward inclined horizontal, the long axis of the insect assumed to lie horizontally; the stroke direction never inclines forward from the vertical nor backward below the long axis of the insect; this is impossible for anatomical reasons. As fact No. 2 we know that the inclination of the wing is always somewhere between parallel and perpendicular to the direction of the stroke, with the anterior margin showing forward and downward; similarly, on anatomical grounds the wing cannot strike with the posterior margin in the lead. As fact No. 3 we know that the duration of the downward and upward strokes can be equal or unequal, thus the effectiveness of forces generated is dependent on this. Now we can construct a table (Fig. 2) that describes the supposed force systems that can arise in connection with insect wing-strokes in all possible cases. If we consider the three facts mentioned and take, in regard to Facts No. 1 and 3, three cases, Fact No. 2, separately concerning down and up strokes, each of them three cases, i.e., two extremities and an average case, we obtain  $3^4 = 81$  cases which describe all the possibilities within the limits of the conditions made. Because the strongest part of the wing is the anterior margin, and the posterior one is much weaker and flexible, and because there is very little reason to assume that the insect would profit by striking the wing inclined completely to the stroke direction, except in some possible special cases, we restrict ourselves in regard to Fact No. 2 to the "average" cases which we consider to be the ones by aid of which it is most profitable for an insect to fly forward, vertically, or backward (Fig. 3). In the case of vertical flight, if we assume that the impulse given by the wings is more or less effective than the weight of the insect or exactly annuls the latter, we have the upward, downward or stationary flight.

If we wish, we can turn these systems clockwise or counter-clockwise around the central point and thus have additional cases of flight. The vectors do not describe the real path of the wing, but only symbolize the direction and effectivity of the force in regard to the insect.

During the summer 1948 and the preceding one I have stroboscopically investigated the real form of the wing-stroke. The last observations have been made by aid of a General Radio Strobotac, for which I am gratefully indebted to the Elizabeth Thompson Science Fund of Harvard University. I have found that the normal progressive flight of



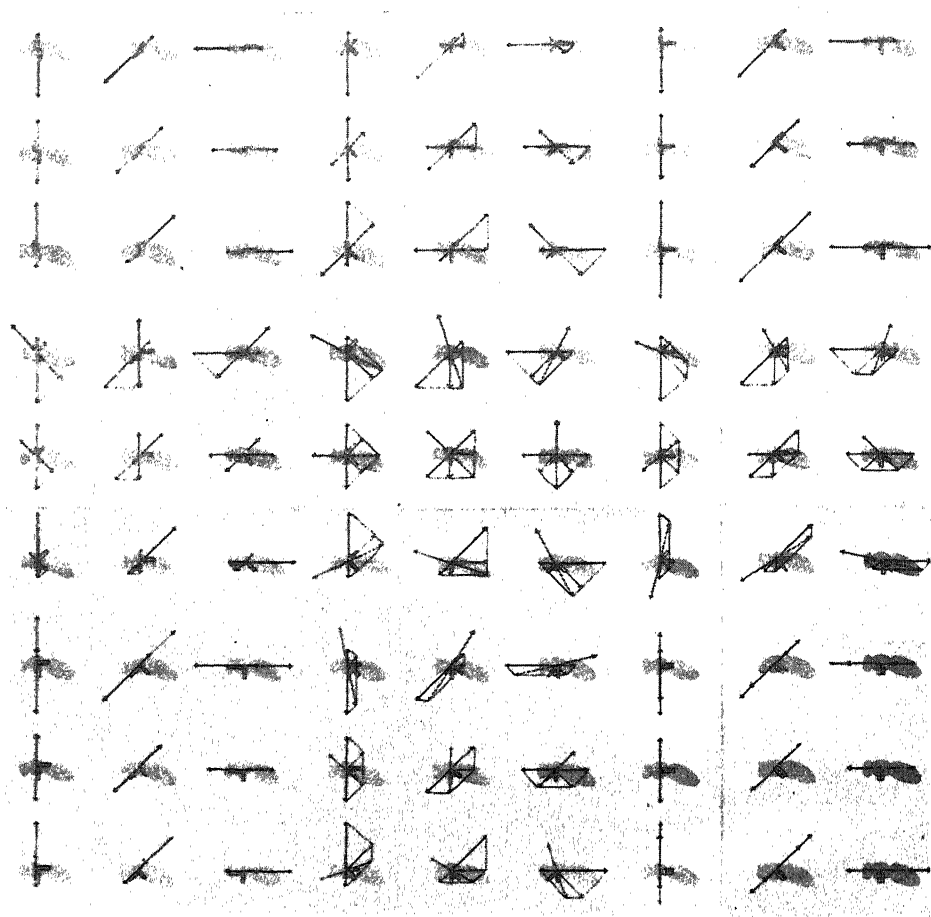


Fig. 2. 81 cases of the force system of the wing-stroke of an insect.  
 Explanations as in Fig. 1.

insects takes place exactly this way. The wings make movements inclined approximately at the same angle to the stroke direction as described here. Moreover, the upward stroke has in most cases a shorter duration and thus is more effective, as described in Fig. 1. This fact is not so easy to see because the frequency of wing-strokes continually has a slight variation and thus is difficult to be uninterruptedly followed by the stroboscope. If the insect is fixed or flies slowly, the turning changes of the wing-plane at the extreme points downward and upward are large, if rapidly, the changes are very slight. This is due to the fact that the path of the wing-stroke of a fixed insect has the form of a long, narrow, and oblique eight, but in rapid progressive flight stretches out to a wave figure, and the angle between the inclined wing and the stroke direction is approximately constant. Because of the speed ( $\therefore$  kinetic energy) the insect already has, in the latter case it does not need any extreme accessory forward impulses by the

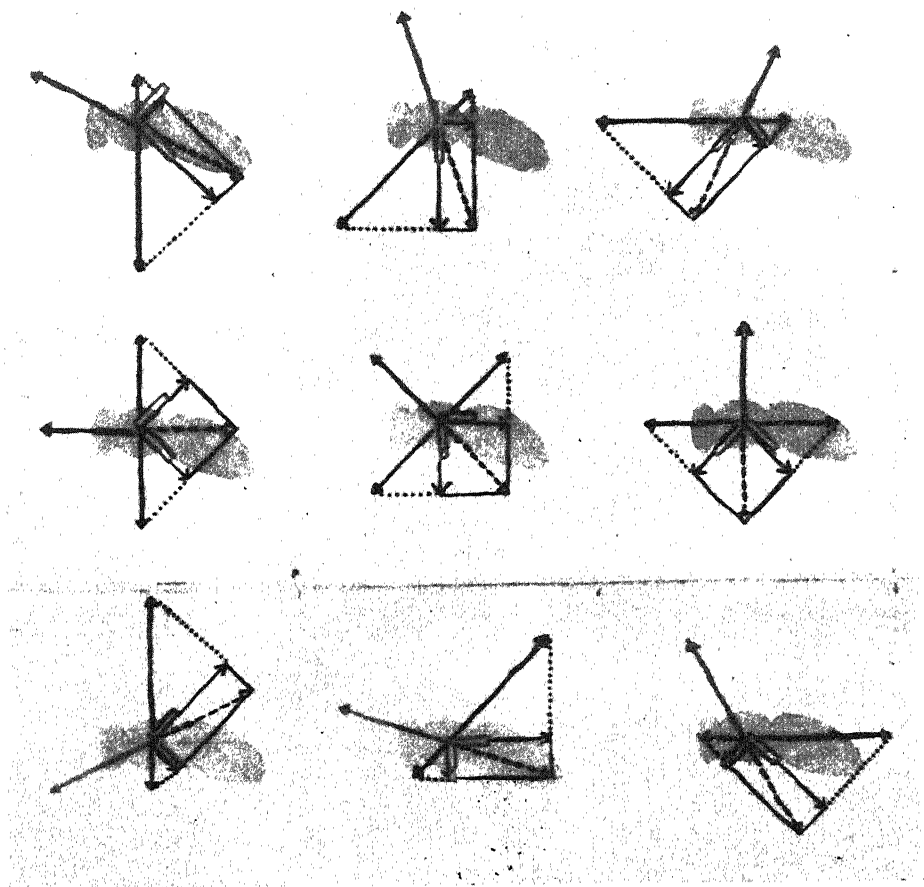


Fig. 3. 9 "average" cases taken from Fig. 2. Explanations as in Fig. 1.

wings and thus can use lesser changes of the wing plane.—I expected also to investigate the stationary flight of the hawkmoths in the same way, but, unfortunately, these expectations for the present have failed, so that the above theory has in this respect not yet been confirmed.

But already these results give rise to further thoughts. If we imagine ourselves following the wing-stroke of a flying insect from the front, we see it like Fig. 4. Now we can compare the wing function with the function of two one-armed airscrews rotating symmetrically around a common axle in opposite directions. The only difference is that when the wings have reached the extreme points downward and upward (*A*, *B*), in the airscrew the wings continue their revolution, in the insect, on the contrary, *de facto*, a turning-around of the wings and an inversion of the wing-planes take place, but, *de praxi*, each of the wings continues the revolution of its opposite partner. The fact that in many insects, due to a small stroke-angle, a part of the stroke plane is

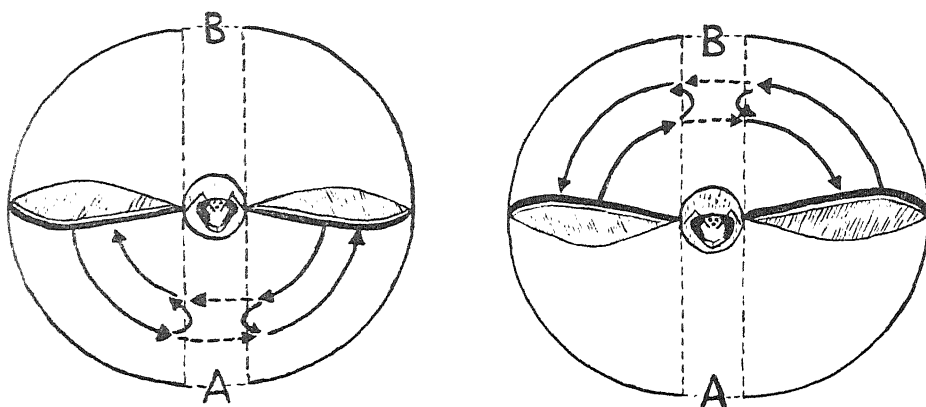


Fig. 4. The upward and downward strokes of insect wings seen from the front. Schematized.

absent around *A*, or, though not often, around *B*, has no essential effect. We can thus compare the insect wing system so much more with the screw propeller system and thus consider the insect as a living helicopter.

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## PROTEIN METABOLISM AND NITROGEN FIXATION BY MEANS OF MICROORGANISMS LIVING IN SYMBIOSIS WITH INSECTS

By *L. Tóth*

A great number of insects can live on foodstuffs extremely poor in protein or other compounds containing nitrogen. This was experimentally demonstrated by Cleveland (1925) when he showed that termites can live indefinitely on a pure cellulose diet.

Also, the food of aphids contains a low amount of protein, sometimes equal or less than given off in excrement. Former investigations on protein requirements of aphids show that during intense reproduction they lose and are compelled to replace each day the total protein content of their bodies. It is evident that they cannot satisfy their nitrogen requirements from the food which is poor in nitrogen. The question now is if there are other sources than food for the nitrogen requirement.

In order to decide this question investigations were made on the respiratory quotient of the aphids. The RQ was found to amount 0.86, which is impossible to explain by the kind of food consisting of an overwhelming proportion of carbohydrates. Therefore there must be another source of energy which is a factor in protein metabolism (independent of the food taken in per os).

Now it has been shown that aphids are able to profitably utilize the protein materials of their symbiotic microorganisms. Since these microorganisms are confined in the aphids they can obtain only the same food as the host and, of course, atmospheric nitrogen. Now, the key question is, can the microorganisms build up amino acids and proteins from carbohydrate furnished by the host and nitrogen obtained from the air. This probably means that we have here the same type of nitrogen fixing symbiosis as in leguminous plants.

This hypothesis can be tested by experiments based on improved methods. The manometric method of Cleveland was found to be unsatisfactory so Tóth, Wolsky and Bátori (1942) developed a method closely approximating natural conditions through the use of crushed insects containing surviving cells and living symbiotic bacteria in a physiologically optimal medium. At regular intervals samples of the material were taken and the total nitrogen determined by the Parnas-Wagner micro Kjeldahl method.

Gain in nitrogen in the surviving system of:

Aphididae	100 0/0—150 0/0
Homoptera	50 0/0—120 0/0
Heteroptera	20 0/0—80 0/0
Kaloterмес flavicollis	67 0/0

Results show that nitrogen fixation is vigorous; an increase of over 100 0/0 within 2 hours occurs in aphids. Experiments with a wide variety of insects show that this type of nitrogen fixation is rather common. This method reveals that there is a significant increase of nitrogen, no doubt due to bacterial activity, with or without the interaction of insect cells or their products. We have filtered the material and the bacteria-free filtrate reveals no ability to fix nitrogen. But we do not know if the intracellular symbiotes are responsible for nitrogen fixation.

Further experiments revealed new facts, especially that the nitrogen fixing microorganisms are able to thrive outside of the insects on a nitrogen free agar medium.

This means that the nitrogen contained in bacterial proteins must have been taken from the air. We believe that most of the cultivated bacteria obtained from the different insects (orders: Aphidida, Homoptera, Heteroptera, Coleoptera) belong to the *Azotobacter* group but no determinations have been made and we have no knowledge of the relationship between these bacteria and the intracellular symbiosis of the insects.

With the aid of these bacterial cultures we can test the efficiency and get an idea of the mechanism of the nitrogen fixing process. For these tests we use the following ingredients to make nitrogen free culture liquid:

0.5	0/0	glucose
0.2	0/0	acidum succinicum
0.5	0/0	NaCl
0.1	0/0	CaCO <sub>3</sub>
0.1	0/0	MgSO <sub>4</sub> · 7H <sub>2</sub> O
0.07	0/0	K <sub>2</sub> HPO <sub>4</sub>
0.03	0/0	KH <sub>2</sub> PO <sub>4</sub>
0.05	0/0	CaCl <sub>2</sub>
0.01	0/0	MnSO <sub>4</sub>
0.0001	0/0	Na <sub>2</sub> MoO <sub>4</sub> · 2H <sub>2</sub> O
0.01	0/0	agar
		Na <sub>2</sub> CO <sub>3</sub> to pH 7.6
		sterile tapwater.

Samples of inoculated culture liquid are analysed every day for total nitrogen content. By varying the experimental conditions extremes and optima of fixation were determined. Optimum conditions were found to be: temperature, approximately 32° C; pH 7.6; osmotic pressure expressed in NaCl concentration 0.85 0/0.

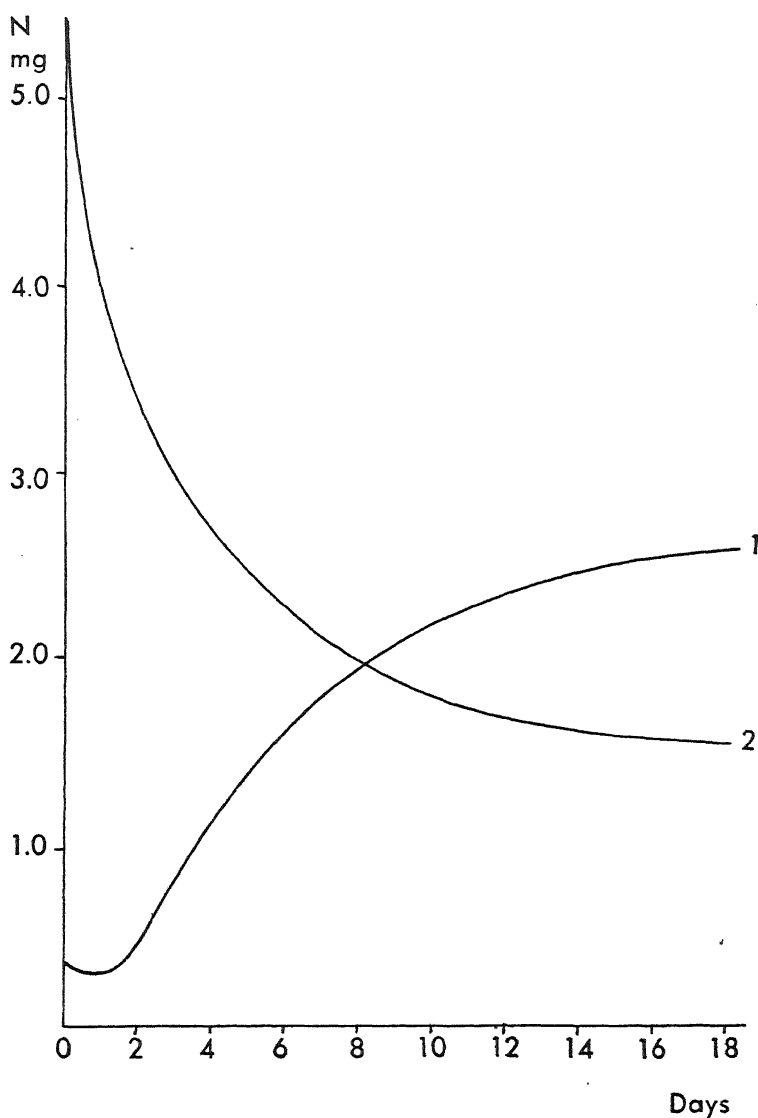
An important requisite for nitrogen fixation is the presence of a suitable carboxylic acid. Aeration makes nitrogen fixation unsteady. Un-aerated cultures fix more nitrogen than aerated cultures except for a few cases where aeration results in vigorous fixation. The use of purified or unpurified air makes no differences in the results, showing that molecular nitrogen alone is used by the nitrogen assimilation.

Nitrogen content of 100 ml nitrogen-free culture liquid (at the start and after 2 weeks) inoculated with cultivated microorganisms of:

<i>Aphis brassicae</i> L.	0.36 mg	2.56 mg
<i>Aphis sambuci</i> L.	0.34 »	2.50 »
<i>Hysteropterum grylloides</i> F.	0.30 »	2.32 »
<i>Lepyronia coleoptrata</i> L.	0.32 »	2.26 »
<i>Pyrrhocoris apterus</i> L.	0.28 »	2.18 »
<i>Spilosthetus saxatilis</i> L.	0.32 »	2.12 »
<i>Pyrrhidium sanguineum</i> L.	0.26 »	2.16 »

Results show that in all cases nitrogen increase is significant. There are no great differences in the nitrogen fixing efficiency of the bacteria from different insects. *Azotobacter chroococcum* under the same experimental conditions fixed less nitrogen than the bacteria of the insects. The bacteria of the insects fix a maximum value of approximately 3 mg per 100 ml culture liquid, starting with 0.30 mg per 100 ml. If we artificially add nitrogen compounds to the culture so that a concentration of 3 mg per 100 ml culture liquid is exceeded than the nitrogen content drops.





Increase (1.) and decrease (2.) of nitrogen in 100 ml liquid culture medium inoculated with bacteria of *Aphis brassicae* L.

Curve 1. shows that there is vigorous nitrogen fixation (in nitrogen free culture liquid); curve 2. shows nitrogen liberation by the same microorganisms. Therefore the process seems to be reversible: when the concentration of the nitrogen compounds is low nitrogen is fixed and if it is high nitrogen is released.

Now the question is just what role this type of nitrogen fixation process plays in animals in a normal environment. In general, this process is probably unimportant but

it may be important if the food is nitrogen deficient or when other microorganisms utilize the nitrogen in the food mass and leave insufficient nitrogen for the nitrogen fixing microorganisms. It is also possible, that other microorganisms utilize the nitrogen compounds produced by the fixers continuously, so, that the nitrogen concentration of the solution remains very low in spite of the steady production of living proteins. It is also evident that the increased mass of plasma-proteins may serve as a fully prepared protein food to the host animals.

Until recently it was considered impossible that the molecular nitrogen of the atmosphere could take any active part in the metabolism of animals. These investigations now provide experimental proofs that many (about 30) species of insects are able to fix the free nitrogen of the air. Thus, it seems to be a widespread phenomenon in the animal kingdom.

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## THE INSECT EPICUTICLE

By V. B. Wigglesworth

It has long been recognised that the epicuticle plays a part of prime importance in the restriction of water loss from the surface of the insect. It was shown by Ramsay (1935) that the cockroach is rendered waterproof by a film of lipoid material which undergoes a change of phase when it is warmed above 30° C and then water can readily pass through. Similar observations have been made on a wide range of other insects (Wigglesworth, 1945) and it has been found that in all of them there is a more or less abrupt increase in the rate of transpiration when the temperature exceeds a certain critical level peculiar to each species or developmental stage. The change may occur from 30° C to 60° C in different insects—in some while they are still alive, in others long after they have been killed by the high temperature. In general, insects from dry surroundings, which are resistant to desiccation (such as *Tenebrio* or *Rhodnius*, or the pupa of *Pieris*) have a high critical temperature; insects less resistant to drying (such as *Blattella*, larvae of the sawfly *Nematus*, or the *Pieris* larva) have a much lower critical temperature.

These differences can be related to the properties of the lipides which can be extracted from the cast skins of these same insects (Beament 1945). In the drought resistant forms they are hard crystalline waxes; in the caterpillars and sawfly larvae they are soft waxes; in the cockroach the material is a semi-solid grease. When spread as a thin film on artificial membranes they form waterproof layers; and when they are heated these films become more permeable to water at a temperature which agrees very well with the critical temperature in the intact insect of the corresponding species. This temperature is some five or ten degrees below the melting point of the wax; it probably represents the temperature at which the agitation of the orientated long-chain wax molecules overcomes the attractive forces between them so that the crystalline film is loosened and water molecules can pass through.

We are mainly concerned here with the way in which the wax layer is built in to the epicuticle. The epicuticle, which appears in histological sections as a single or double layer, has been found to be highly complex. It is not easy to obtain a clear idea of its constituent layers from a study of the completed structure. It is best studied while it is being laid down at the time of moulting. This has been done in *Rhodnius* (Wigglesworth 1947) and in the adult *Tenebrio* (Wigglesworth 1948). The main outlines of the process are similar in the two insects.

The cells first lay down a refractile membrane of lipoprotein which stains grey in osmic acid. This is termed the "cuticulin layer"; there is some evidence that the lipo-proteins of which it is composed are produced by the oenocytes. It has the appearance of a homogenous membrane, but it is in fact penetrated by the cytoplasmic filaments from the epidermal cells which will later form the pore canals. From the tips of these filaments there soon exudes a liquid secretion which actively reduces ammoniacal silver hydroxide. At first the minute droplets of this substance are limited to the ends of the pore canals, but as they increase in size they spread and fuse with adjacent droplets until they form a more or less continuous film. This material is thought to consist of dihydroxyphenols combined with protein. It is termed the "polyphenol layer". Without staining in silver it has not been possible to demonstrate

this layer, but its existence may be further proved by the fact that in the early stages of its secretion it may be displaced and caused to fuse into irregular masses by touching the surface of the cuticle with a slip of filter paper before treating with the silver.

Within an hour or two before moulting the "polyphenol layer" becomes covered over so that only occasional points are stained when the exposed new cuticle is immersed in ammoniacal silver. It is at this stage that the "wax layer" is forming over the polyphenols. The wax is secreted by the epidermal cells, presumably through the pore canals and appears to crystallize out over the surface. Nothing is known of the mechanism of this secretion; but it is worth noting that a similar waterproofing layer of wax is laid down by the tick *Ornithodoros* over its eggs. Lees and Beament (1948) have recently produced evidence that this wax, the product of Géné's organ, is solubilized by association with protein which is detached and perhaps reabsorbed when secretion is complete. The presence of the wax layer on the cuticle at this stage is evidenced by the hydrophobe properties of the exposed surface and by the fact that the slightest abrasion with fine dusts or brief treatment with lipid solvents at once exposes the polyphenol layer again.

Shortly after moulting a fourth layer is added to cover the wax. This is called the "cement layer". It is poured out from the unicellular dermal glands whose ducts open on the surface of the cuticle. In *Rhodnius* the discharge of this layer is indicated by the disappearance of the hydrophobe properties of the surface. Within an hour or so after moulting, droplets of water will adhere and spread on the cuticle; and at the same time the glands are found to have emptied the contents of their distended vesicles. In *Tenebrio* the change in wetting properties is not so striking, but the evacuation of the gland contents occurs in the same way soon after moulting and, at the same time, exposure of the underlying polyphenol layers by extraction in chloroform becomes more difficult.

The presence of a cement layer formed in this way has been demonstrated in *Rhodnius* and *Tenebrio*, in the tick *Ornithodoros* (Lees 1947) and recently by Way (1948) in the Noctuid caterpillar *Diataraxia*, in which it is secreted by Verson's glands. The chemical nature of the cement needs further study. It appears to be a phenoltanned protein, perhaps combined with lipid material of some kind. In its normal state it does not reduce ammoniacal silver; but after extraction with boiling chloroform it stains as a finely granular membrane.

This property may be used to demonstrate the dermal glands. If the *Tenebrio* adult at the moment of moulting is boiled in chloroform and then immersed in ammoniacal silver the contents of all the distended dermal glands stain black. In the *Rhodnius* nymph there are two sorts of glands; numerous glands with oval vesicles distended with a watery solution of protein and scattered glands with convoluted vesicles. Only the latter stain black with silver after chloroform extraction. Apparently the cement in *Rhodnius* is made up of two components; and in this respect it resembles the substance of the oötheca of the cockroach as described by Pryor (1940). This is the product of two glands, one of which secretes a protein solution and the other a dihydroxyphenol.

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## DÉVELOPPEMENT EMBRYONNAIRE ET POSTEMBRYONNAIRE DU DORYPHORE (*LEPTINOTARSA DECEMLINEATA* SAY) EN FONCTION DE LA TEMPÉRATURE

Par J. de Wilde

### *Introduction*

Les Pays-Bas appartiennent aux pays les plus nordiques de l'aire européenne du Doryphore; nous pouvons donc nous attendre à ce que notre climat ne favorisera pas toujours le développement de cet Insecte, originaire de régions plutôt méridionales; il est probable, au contraire, que des facteurs climatologiques appartiennent aux principaux facteurs de limitation déterminant le développement et l'infestation. Sans aucun doute la température occupe ici la place la plus importante. Partant de cette supposition, nous avons commencé en 1946 à étudier l'influence de la température en tant que facteur oecologique sur le développement du Doryphore.

Notre expérience concernant le développement du doryphore aux Pays-Bas est de date récente. On sait que, jusqu'en 1944, on n'a trouvé le doryphore que sporadiquement dans notre pays; des foyers se présentant incidemment ont toujours été détruits grâce à l'activité de nos Services Phytopathologiques; pendant la deuxième guerre mondiale, cependant, un contrôle effectif dans le sud de la Hollande a été impossible à partir de 1944 et notre pays a été infesté définitivement.

Si nous comparons le développement du fléau aux Pays-Bas de 1945 à 1948 d'année en année, il est déjà évident que les conditions climatologiques jouent un rôle considérable. L'été de 1945 a favorisé le développement par des températures très élevées qui se sont annoncées très tôt dans l'année; par contre, le doryphore a manifesté une activité remarquablement petite pendant l'été froid de 1946. L'été de 1947, exceptionnellement chaud pour notre climat, a montré un développement excessif; en 1948 l'été était froid jusqu'au fin de juillet et l'activité surprit par son insignifiance, surtout en considérant les occasions propices à l'accroissement pendant l'été précédent.

### *Développement saisonnier-problèmes posés*

L'influence de la température se manifeste clairement aussi dans le cours du développement dans chaque saison, avant tout pendant les premières semaines de la période de reproduction.

Quoique, pendant les trois années où l'on s'est occupé de cet examen, une partie considérable des adultes firent leur apparition dans le courant d'avril déjà et, quoique la feuillaison des espèces de pommes de terre précoces et mi-précoces fût déjà très abondante fin avril, on a toujours constaté le début de l'oviposition au mois de mai.

Il était curieux de noter qu'apparemment une période d'oviposition intensive n'entraîne pas nécessairement le développement d'un grand nombre de larves. En 1946 l'oviposition a commencé pendant quelques journées chaudes aux environs du 13 mai, qui furent suivies par une période plutôt froide; ce n'est qu'après le 27 juin qu'un nombre considérable de larves s'est développé dans les champs, après une hausse considérable de température. En 1948 nous avons constaté un fait analogue; l'oviposition a commencé aux environs du 8 mai; après cette date la température a baissé considé-

ablement. Quoique beaucoup d'œufs fussent pondus pendant cette période, le développement des larves restait insignifiant; jusqu'à ce que, aux environs du 8 juin, la température ait monté de nouveau.

La reprise du développement fut pourtant anéantie par une nouvelle baisse de température.

Ces observations donnent lieu aux questions suivantes :

1. Quel rapport existe-t-il entre la température et le début de la période d'oviposition?
2. Quel rapport existe-t-il entre la température et le développement des œufs et des larves? Ces stades, ont-ils un seuil de développement différent?
3. Peut-on déterminer, en vertu de ces données, à quels moments la température a limité, ou même arrêté, le développement des œufs et des larves?
4. Peut-on se faire une idée sur les possibilités de développement du doryphore dans une région déterminée, en partant exclusivement d'observations climatologiques?

Nous avons essayé de répondre à ces questions de la manière suivante:

1. Au laboratoire nous avons réalisé des élevages par des températures différentes, où nous nous sommes servis d'un thermostat multiple selon Zwölfer<sup>2</sup>.
2. Nous avons fait, à plusieurs endroits, pendant toute la saison des élevages dans des cages en plein air (fig. 1).
3. Nous avons fait des observations dans les champs.



*Fig. 1. Cages d'observation. Jardin expérimentale du Laboratoire d'Entomologie d'Amsterdam.*

### *Oviposition*

Notre collègue Grison a traité, dans une conférence antérieure, le rapport entre la température et l'activité de l'imago. Aussi nous aimerions nous limiter à la mention de l'expérience suivante, réalisée en 1948 :

Des couples de doryphores, posés dès leur émergence sur des pousses de pommes de terre dans le thermostat multiple par des températures de 13°, 17°, 21°, 25° et 30° C, ne pondirent pas d'œufs par une température de 13° et 17° C, même après 3 semaines. Par une température de 21°, 25° et 30° C l'oviposition commença respectivement après 5, 4 et 3 jours. Si nous transportions, après quinze jours, les pondeuses d'une tem-

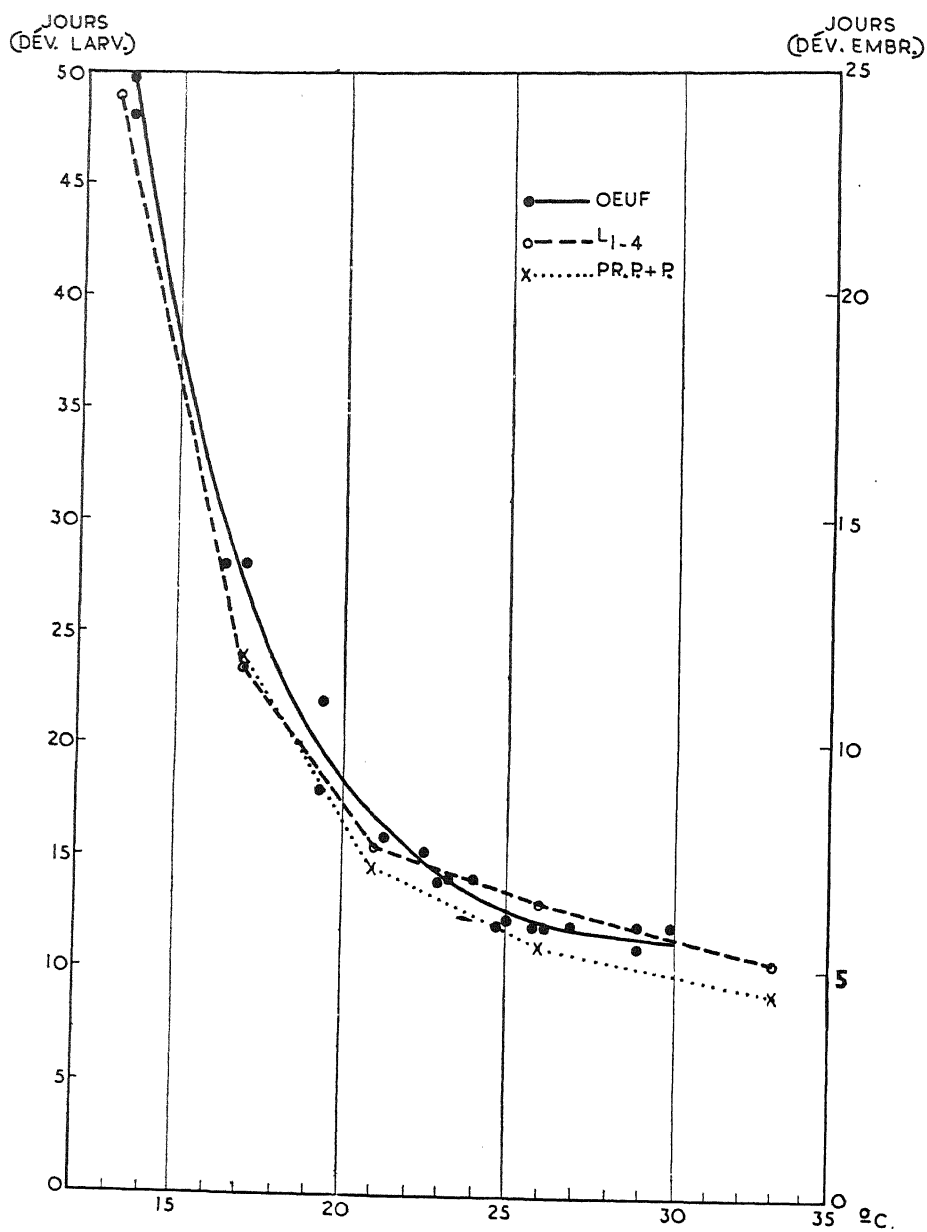


Fig. 2a. Durée de développement embryonnaire et postembryonnaire en fonction de la température.



pérature de  $30^{\circ}$  à  $13^{\circ}$  C, l'oviposition se continua pendant une semaine, ne fût-ce qu'à une fréquence fort diminuée. Dans les champs nous avons observé aussi que l'oviposition, commencée par une température élevée, s'est continuée lors d'une nouvelle baisse de température.

### *Développement embryonnaire*

Le rapport entre la température et la durée du stade des œufs est représenté par la figure 2 a.

Les données se rapportent à des élevages dans le thermostat multiple et dans des hygrostats à une Humidité Relative de 85—100 %.

Le seuil de développement se trouve à  $12^{\circ}$ — $13^{\circ}$  C.

Par une température de  $30^{\circ}$  C environ, le développement se fait d'une vitesse maximum (en  $5\frac{1}{2}$  jours).

Comme nous pouvions nous y attendre, l'hygrométrie influe considérablement sur le développement des œufs. C'est ce que nous avons examiné à l'aide de tubes d'hygrostat (fig. 3) placés dans le thermostat multiple. Il était possible d'obtenir ainsi des combinaisons de R. H. de 40, 60, 70, 80, 90 et 100 % et de températures de  $16^{\circ}$ — $30^{\circ}$  C.

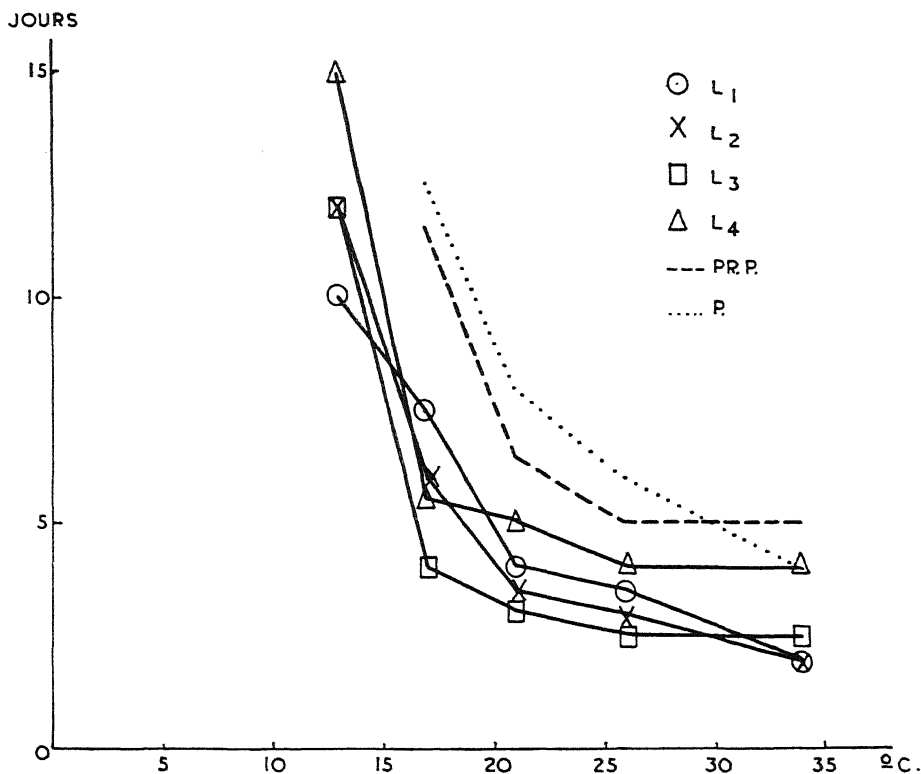


Fig. 2 b. Durée de développement des stades larvales et pupales en fonction de la température (élevage isolé).

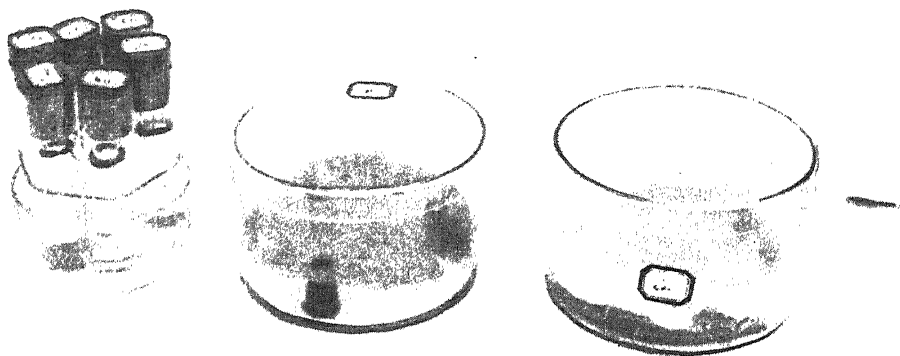


Fig. 3. Tubes et boîtes d'hygrostat utilisés dans les expériences.

Pour avoir un tableau synoptique, nous avons combiné dans la figure 4 les résultats des expériences à 40—70 % et à 80—100 %. Il est évident qu'à une même température, et par une humidité de l'air peu considérable, le pourcentage de développement est moindre que par une humidité de l'air élevée, tandis que l'influence sur la durée du développement est minime.

#### *Développement postembryonnaire — température constante*

Des observations dans les champs en 1946 nous ont donné l'impression que les œufs peuvent se développer par une température arrêtant le développement des larves. Pour étudier cette question, nous avons élevé individuellement des séries de 10 larves dans de petits tubes. Les résultats de ces élevages sont représentés dans les diagrammes à carreaux de la figure 5. Ils démontrent que nous n'avons pas réussi à obtenir le développement complet jusqu'au stade adulte par une température constante de 13° et 16.5° C.

Sous des conditions très favorables le développement jusqu'en  $L_4$  était possible à 13° C, le développement jusqu'en praepupe à 16.5° C. En élevant les  $L_1$  à 25° C jusqu'à un âge supérieur, nous avons obtenu, pendant une période ultérieure de température basse (14° C p. ex.), un développement bien plus important; celui-ci s'écoulait d'une façon beaucoup plus satisfaisante à mesure que nous avons poussé l'élevage préliminaire jusqu'à un stade plus avancée (fig. 6).

Ainsi nous avons réussi à établir la durée de développement de tous les âges en fonction de la température. La figure 2 a représenté la durée de développement des

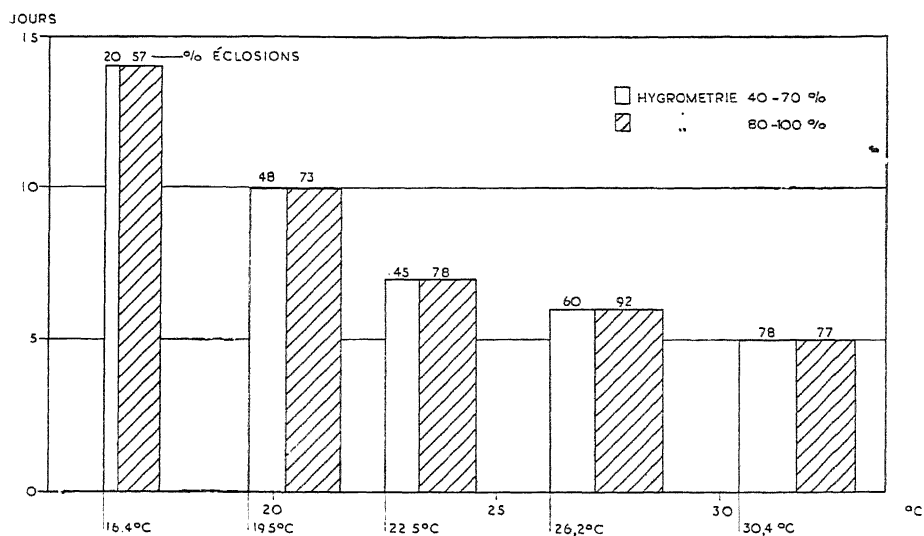


Fig. 4. Durée de développement et % éclosions des oeufs en fonction de la temp. et de l'humidité.

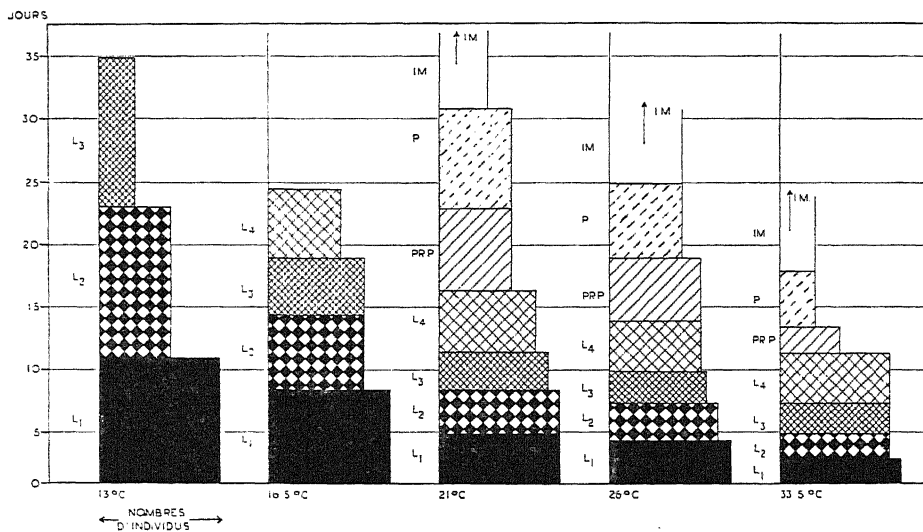


Fig. 5. Durée de développement et mortalité larvaire et pupale en élevage isolé, en fonction de la température.

stades larvaires ( $L_1$ — $L_4$ ). Nous constatons que la courbe montre un parallélisme frappant avec celle du stade embryonnaire. Le seuil de développement paraît être le même pour les deux phases, c'est-à-dire  $12^{\circ}$ — $13^{\circ}$  C. La figure 2 b donne plus de détails. Il paraît que le "seuil de développement" se trouve à un degré plus élevé pour les stades souterrains que pour les stades de surface, c'est-à-dire à  $15^{\circ}$ — $16^{\circ}$  C.

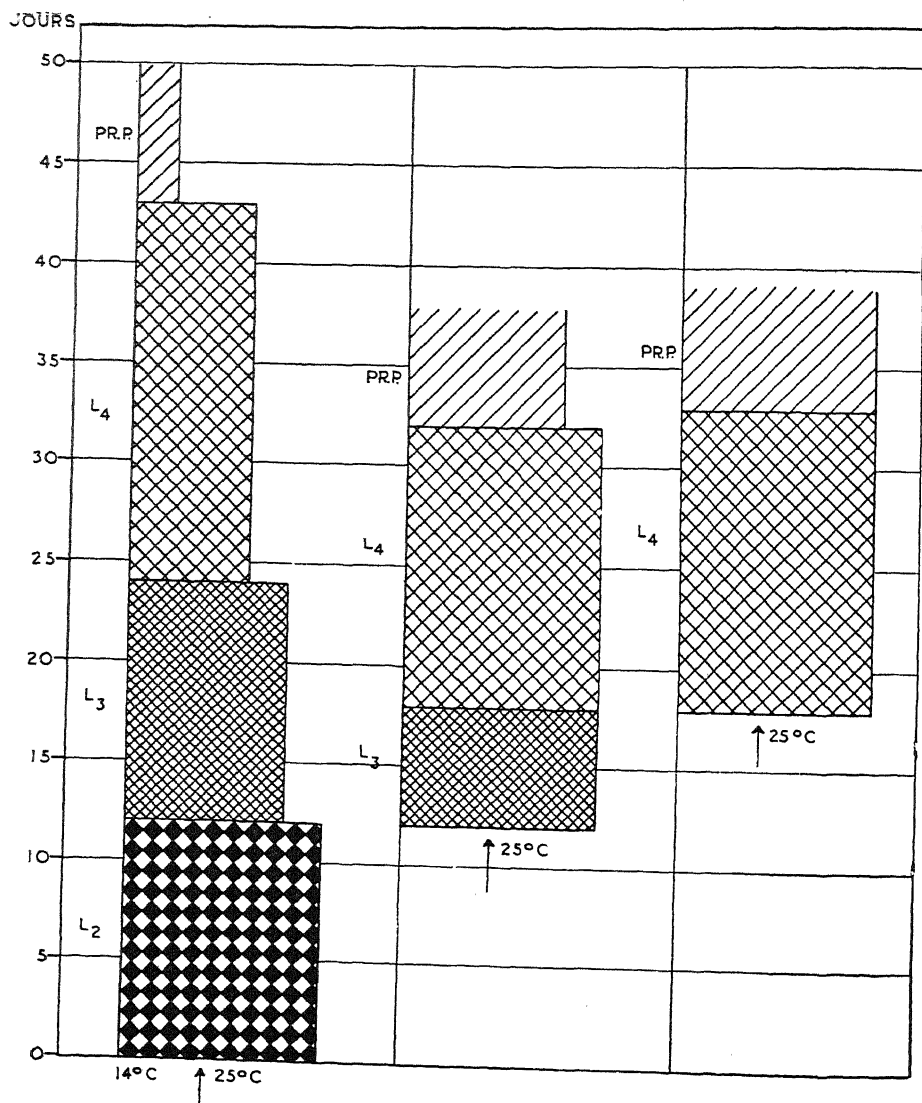


Fig. 6. Durée de développement et mortalité des stades larvaires élevés à  $14^{\circ}$  C (élevage préliminaire à  $25^{\circ}$  C).

*Température variable*

Si nous voulons examiner, en vertu de ces données, les possibilités de développement de la population des larves dans les champs, il nous faudra tenir compte de grandes oscillations de température. Nous avons voulu savoir si notre seuil de développement, établi par une température constante, est valable aussi pour des températures variables.

A cette fin nous avons monté une série d'élevages en faisant varier les températures, où, chaque jour, les larves étaient exposées à une température élevée de 9h. à 17h et de 17h. à 9h. à une température basse. A l'issue de ces élevages nous avons établi pendant combien de temps les larves avaient été soumises au total à chacune de ces deux températures. Ces totaux ont été comparés avec la durée de développement par une température constante pour chacune des deux valeurs.

La figure 7 représente le résultat de quelques-unes de ces expériences. Nous constatons que, en vue du développement complet des larves, la durée d'exposition à une

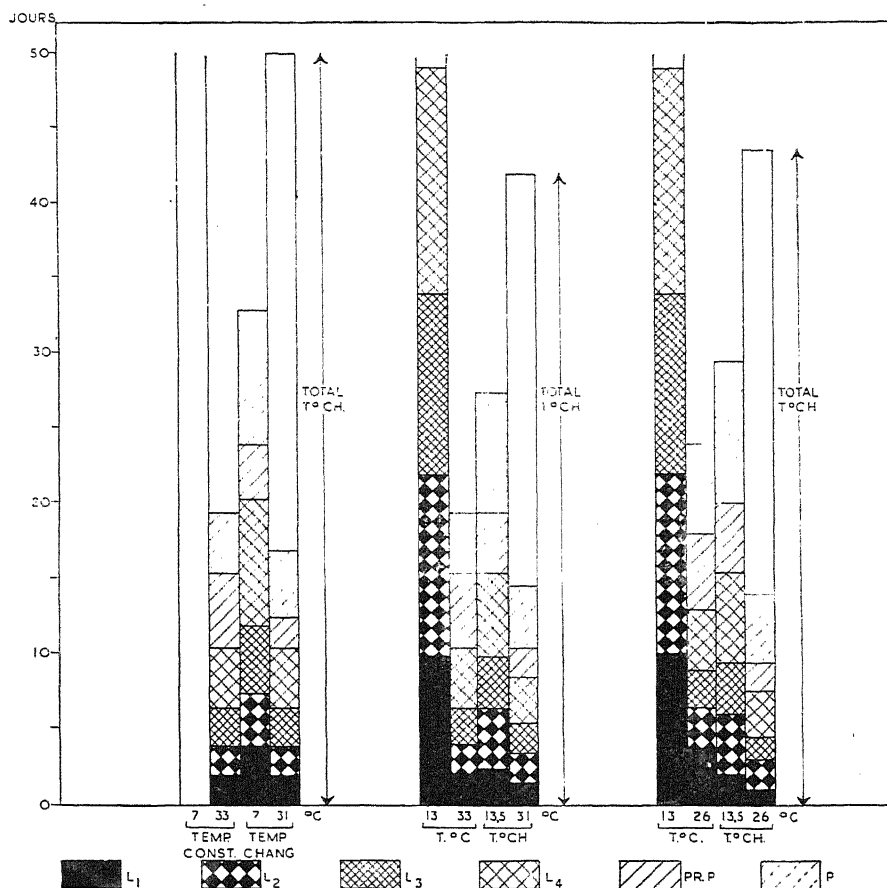


Fig. 7. Durée de développement postembryonnaire en fonction de températures constantes et changeantes.

température de  $30^{\circ}\text{C}$  doit rester la même dans les expériences à température constante ( $30^{\circ}\text{C}$ ), que par une température alternante ( $7^{\circ}$  et  $30^{\circ}\text{C}$ ). Cela signifie qu'à  $7^{\circ}\text{C}$  il n'y a pas de développement. De la même façon on peut contrer qu'il y a déjà du développement à  $13\frac{1}{2}^{\circ}\text{C}$ ; celui-ci n'est pourtant que peu considérable. On obtient l'impression qu'en alternant encore la température le seuil de développement ne se trouvera pas loin au-dessous de  $13^{\circ}\text{C}$ . Nous sommes encore en train d'examiner le problème de savoir si l'alternance de température supérieure au seuil de développement exerce une influence stimulante sur le développement.

#### *Facteurs secondaires — seuil écologique*

En considérant l'importance de la température par rapport au développement dans les champs, il nous faut tenir compte de facteurs secondaires. Nous pouvons considérer comme tels l'état de la feuillaison, la pluviosité et le vent.

Nos élevages ont démontré déjà qu'il est très difficile d'élever une larve jusqu'à la phase praepupale par une température constante au-dessous de  $17^{\circ}\text{C}$ . Par des températures tellement basses l'activité d'alimentation est si limitée, qu'en peu de temps la jeune larve se rabougrit et meurt par suite d'inanition. Dans les champs les influences abiotiques déjà citées ci-dessus, s'y ajoutent encore. De jeunes larves affaiblies par des températures basses sont facilement enlevées des plantes par la pluie ou par des coups de vent. Si, par contre, la larve a évolué à une phase antérieure par une température élevée, une nouvelle baisse de température est beaucoup moins nuisible. Voilà pourquoi nous pouvons admettre sans crainte  $17^{\circ}\text{C}$  comme seuil de développement écologique des jeunes larves dans les champs ( $1^{\circ}$  et  $2^{\circ}$  stade), même si le seuil théorique se trouve plus bas.

$12^{\circ}\text{C}$  est le seuil de développement pour le développement des œufs. Un développement que nous aimerions appeler optimal commence à une température de  $25^{\circ}\text{C}$ . Le développement larvaire est progressivement possible en montant de  $17^{\circ}$  à  $25^{\circ}\text{C}$ ; par une température de  $21^{\circ}\text{C}$  il devient plus ou moins normal.

#### *Courbe de températures — zones minimum, normal, optimum. Comparaison de la température et de l'infestation*

Nous avons mis en graphique le cours quotidien de la température dans les saisons 1946—1948 et nous avons divisé l'échelle de températures en 5 sections, à savoir 12, 12—17, 17—21, 21—35,  $> 25^{\circ}\text{C}$ . Nous avons suivi parallèlement le développement dans les cages en plein air et dans les champs.

En 1947 la situation était très simple; au début de mai déjà la température maximum monta au-dessus de la limite de  $21^{\circ}$ , la température minimum au-dessus de la limite de  $12^{\circ}$ . Il en résulta un développement rapide des œufs et des larves. Une baisse de température y faisant suite (température maximum au-dessous de la limite de  $17^{\circ}$ ) ne dura que 4 jours, ensuite la température monta et resta élevée 17 jours. Lorsqu'une période de température basse s'annonça ensuite, un grand nombre de larves était déjà "résistantes". Quelques brèves périodes de baisse à part, la température continuait à favoriser le développement dans cette saison, anormalement chaude d'ailleurs pour notre climat néerlandais.

Les années 1946 et 1948, plus représentatives de notre climat, montrent un tout autre aspect. Nous constatons qu'en 1946, jusqu'à la fin de juin, la température maximum ne monta que rarement au-dessus de la limite de  $21^{\circ}\text{C}$ ; elle fréquenta surtout le

minimum (fig. 8).<sup>3</sup> La température minimum se trouva, dans la 3<sup>ème</sup> décade de mai, régulièrement au-dessus de la limite de 12° C. Parallèlement à ceci nous avons constaté l'oviposition dans les champs et dans nos cages, mais les œufs ne se développèrent que lentement, tandis que les larves sorties périrent presque toutes.

Il y eut un changement après le 27 juin; de partout on fit mention de jeunes larves et nous pouvons dire qu'à partir de ce moment on pouvait parler du danger de dégâts. Or, nous constatons que vers ce moment-là la température maximum a dépassé la limite de 21° C pour assez longtemps. Une baisse nouvelle avait peu d'effet, puisqu'elle fut bientôt suivie d'une hausse.

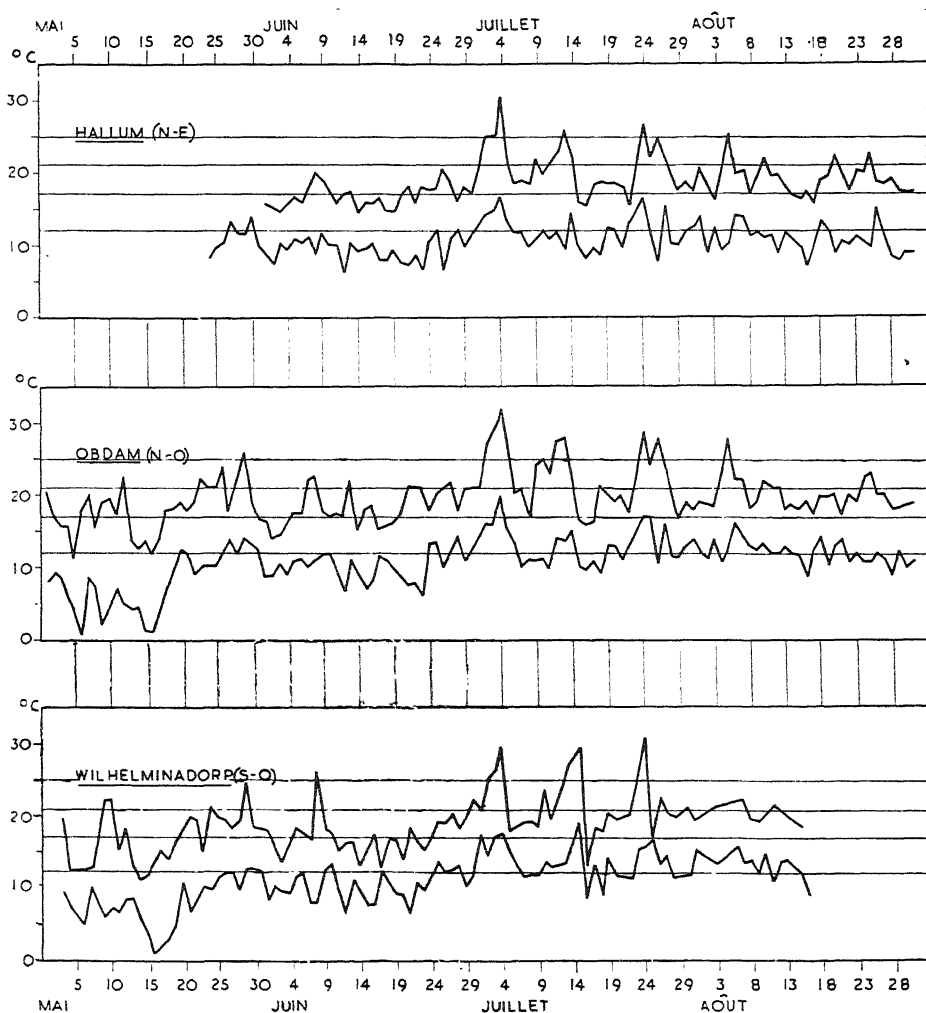


Fig. 8. Température max. et min. dans un champ de pomme de terre à 40 cm de hauteur dans des régions différentes de la Hollande. Année 1946.

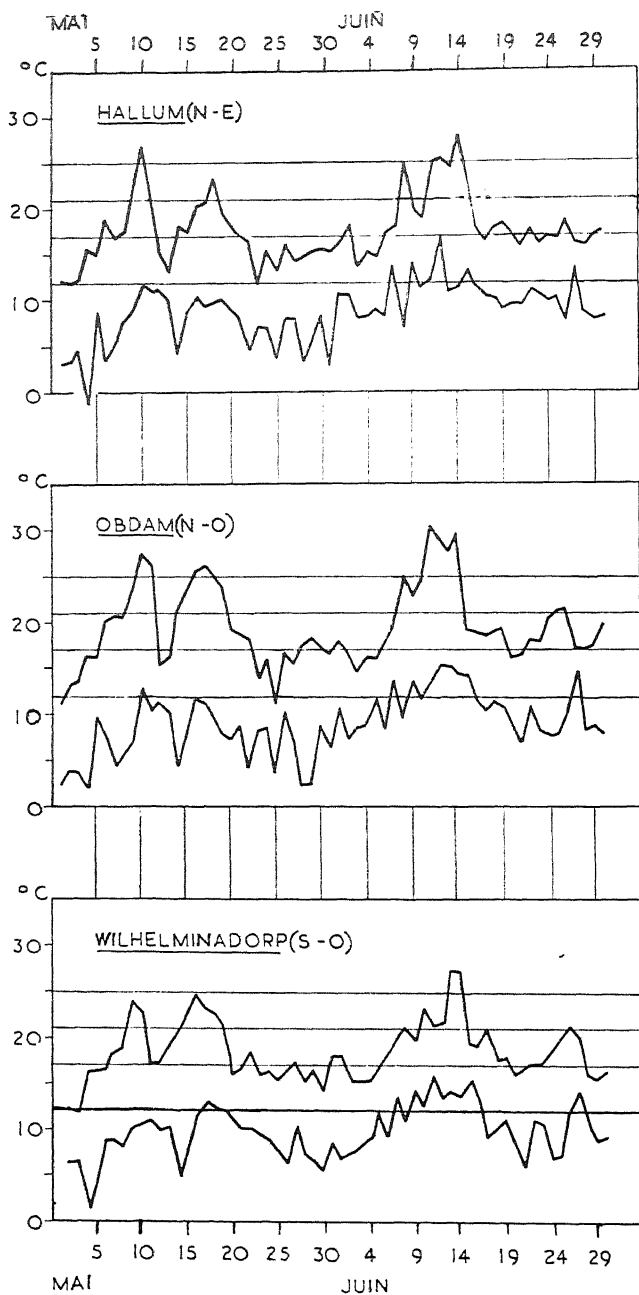


Fig. 9. Temp. maxima et minima dans un champ de pomme de terre à 40 cm de hauteur dans des régions différentes de la Hollande. Année 1948.



Aux mois de mai et de juin, cependant, le développement du fléau avait été ralenti au point qu'il ne s'est que très peu répandu pendant cette année-là.

La saison qui vient de s'écouler (1948) s'est caractérisée par des oscillations de température extrêmement violentes (fig. 9), qui nous ont fourni l'occasion de confronter nos conceptions avec la pratique. Cette fois-ci encore les faits ont confirmé notre point de vue. A l'inverse de 1946, la température maximum a commencée déjà au début de mai à monter au-dessus de la limite de  $21^{\circ}$  C. De brèves périodes de température élevée ont alterné dans cette saison avec de longues périodes de basse température (maxima au-dessous de  $21^{\circ}$  et même au-dessous de  $17^{\circ}$  C). Pendant les mois de mai et de juin nous avons constaté régulièrement beaucoup d'œufs dans les champs. Les maxima étaient extrêmement bas (presque toujours au-dessous de la limite de  $12^{\circ}$  C) de sorte que le développement des œufs était lent et que la mortalité des œufs était considérable.

En vertu du graphique de température, nous devons nous attendre à ce que beaucoup de larves aient pu encore se développer dans les champs du 5 au 15 juin. Cela n'a pas été le cas, surtout par suite des basses températures minima, accompagnées de grand vent et d'ondées qui se sont présentées dans la seconde moitié de juin. Cela a été encore et avant tout le développement des œufs et des larves les plus jeunes qui en ont souffert.

En considérant qu'aux Pays-Bas, aux mois de juin et juillet 1948, la température moyenne se trouvait au-dessus de la normale et que des étés froids comme 1946 ne sont pas rares, nous pouvons admettre comme certain que dans le climat néerlandais la température forme un facteur limitant extrêmement important pour le développement larvaire du doryphore. Il serait intéressant d'étudier la courbe des températures dans des régions européennes où le doryphore ne se présente pas encore et de confronter ces données aux nôtres.

Il nous semble que les résultats obtenus ainsi contribueraient considérablement à nos connaissances concernant les possibilités de propagation de cet insecte, si important du point de vue économique.

<sup>1</sup> Les graphiques ont été exécutés par M. Boogers, de la Min. d'Agriculture néerlandaise.

<sup>2</sup> Propriété du Laboratoire de Zoologie à Leyden.

<sup>3</sup> Les relevés climatologiques ont été mis à notre disposition par le K. N. M. I. de Bilt, que nous remercions de sa grande obligeance.

## AN EXPERIMENTAL PROOF OF THE ACTIVITY OF THE ALARY MUSCLES IN INSECTS

By *J. de Wilde*

### I. *General structure and function*

The dorsal vessel of insects consists of a medio-dorsal, longitudinal tube, separated from the ventral body cavity by the pericardial septum or dorsal diaphragm. The posterior region, the heart, is closed in most insects at the back; the anterior region, the aorta, opens into the head cavity.

The wall of the heart generally consists of three distinct layers: the adventitia, consisting of connective tissue; the media, a muscular layer; and the intima, the sarcolemma of the media.

The pericardial septum is, as a rule, limited to the heart and the posterior part of the aorta. It consists of a membranous network of connective tissue, at the ventral side of which segmentally ranged, fan-shaped bundles of striated muscle fibrillae are placed, the alary muscles. These bundles converge towards the body wall, attaching themselves to the terga. At the medial side they end into chitinous tendons.

In a group of insects (e.g. adult specimen of Orthoptera and Coleoptera) part of these tendons end into the adventitia of the heart, while the others are connected with the tendons of the heterolateral alary muscles. In other cases (adult specimen of Hemiptera and Hymenoptera) the alary muscles are only attached to the heart wall.

The pericardial septum is slightly curved in dorsal direction through its connections with the dorsal vessel. When a heart segment is in diastole, the body fluid is pressed into the pericardial sinus by the downward movement of the septum, and sucked into the heart lumen through the ostia. During systole, the blood is stowed in a forward direction. The speed at which the systolic waves pass the heart tube may be considerable, so that (e.g. with the *Periplaneta americana*) the heart often seems to contract simultaneously.

### 2. *Literature*

In the famous "Biblia Naturae", our fellow-countryman Jan Swammerdam (1) gives the following description of the heart of the caterpillar of *Vanessa urticae*:

"Het is een dun en subtiel langwerpig pijpken, dat veselagtige, langwerpige, en dwars lopende, spieragtige draden heeft, die men niet, dan door een swaare moeyte ende kunst, sien kan. Hier en daar is het eenigszins verwijderd, en dan weer samengetrokken, ook lopen daar eenige longaderen door. Om zijn samentrekking te maaken, heeft het zijn eyge Vesels, maar om het te verwijderen, soo siet men, dat het aan weersijden een groot getal verdeelde Spieren heeft, die als een Spier haar vertoonen, hoewel nogtans dat se ligt te scheyden sijn, en in veele Spieren te separeren."

("It is a thin and subtle, oblong small tube, bearing fibrous, oblong and transversely running, muscle-like threads, which cannot be seen but at the cost of heavy troubles and by great skill. Here and there it is somewhat dilated and then again contracted; also there are some pulmonary veins\* running through it. To perform its contraction, it has its own fibres, but to dilate it, one observes that it has a great number of

\* Tracheae (de W.).

divided muscles at both sides that look like one muscle, though they are easily divided and separated into many muscles.”)

It is evident that this excellent pioneer-observer considers the alary muscles as active muscles, the contractions of which are the cause of heart dilatation.

In later years, however, the results of investigators have become conflicting, as well as regards the contractility of the alary muscles as their function in heart diastole.

The diversity of opinions is perhaps best demonstrated by the following table:

Author	Insect	Contractility	Diastolic function
Verloren (2)	Div. sp.	—	—
Graber (3, 4)	Orthoptera, Coleoptera	+	—
Popovici-Bazosanu (5)	Div. sp.	—	—
Lasch (7)	Lucanus cervus (lv.)	+	—
Brocher (8)	Dytiscus sp. (ad.)	—	—
Kuhl (9)	» » »	—	—
Bethe (10)	Hydrophilus (ad.)	+	+
Dubuisson (11)	Chironomus (lv.) Agrion (lv.)	+	+
Krey (12)	Trichoptera (lv.)	+	+
Yeager (14)	Periplaneta americana	—	—

Results of experiments of different authors on contractility and diastolic function of the alary muscles.

+ = present, — = absent.

Summarizing the results obtained we come to the following points:

1. As the alary muscles are differently developed in different species and even in different stadia of one species, incidental observations on their activity may not be generalised. Authors agree that in the larval forms of Chironomus, Agrion and Trichoptera species the muscles perform rhythmical contractions, as for adult specimen of *Hydrophilus piceus* this forms a point of discussion, and for *Dytiscus* and *Periplaneta* (adults) it is denied.
2. Only for one species (larval form of *Chironomus*) it is proved that the muscles play an active role in heart dilatation.

### 3. Own Experiments

#### a. Technique and material

We made our experiments with adult American Cockroaches (*Periplaneta americana*), large water beetles (*Dytiscus marginalis*, *Hydrophilus piceus*) and Lepidoptera (Larvae of *Smerinthus ocellata*, *Sphinx ligustri*, *Phalera bucephala*, *Bombyx mori*, *Cossus cossus* and adult *Smerinthus o.*, *Lymantria dispar* and *Bombyx m.*). The caterpillars were taken in their last stage.

After the animals being reared or gathered in nature they were kept at the experimental temperature in the laboratory for some days.

Before the experiment the animal was narcotised by treating it with carbon dioxide gas during 1 or 2 minutes. Then it was fixed in reverse position on a cork plate. With caterpillars the dorsal skin was stretched, so as to avoid subsequent contraction of the body muscles. Then the animal was decapitated, the body wall was horizontally intersected by means of iridectomic scissors and the dorsal vessel isolated at the terga or the dorsal body wall. In the preparation obtained these parts form a small basin

in which the heart was kept moist by means of some drops of *Ringer's* solution (conc. NaCl 0.65 %). Prepared in this way, at a temperature of 20–24° C., the heart is active for about 6 hours, though it may beat for 24 h. and more.

Besides studying the heart under the binocular microscope we registrated its pulsations, using the method of Yeager (14). The lever we used is shown in fig. 1. The heart was attached to the lever by means of a flax fibre, at the end of which a small hook

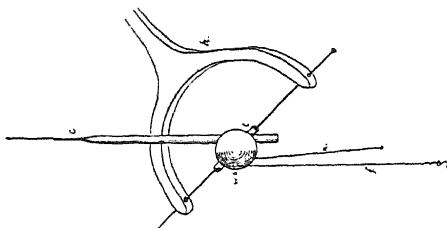


Fig. 1. Lever used for recording heart activity.

was fastened, made of a "micro-needle" (rustless steel). This hook was fastened to the pericardial septum at the desired place.

A scheme of the further arrangement of instruments is seen on fig. 2. The capillary point of the vertical arm of the lever was placed in a horizontal light bundle, the enlarged shadow of the capillary was projected upon the horizontal cylinder lens of a cardiographic camera of Bouillite. The speed of recording was 10 mm/sec.; the enlargement of the amplitude was 20–50 x.

In order to avoid tremblings registrations were performed in a cellar.

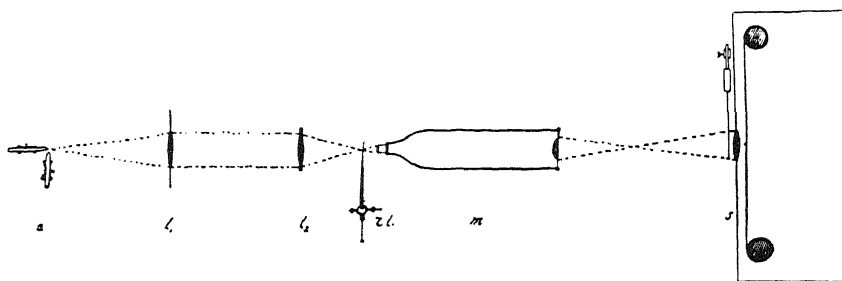


Fig. 2. Arrangement of instruments.

*a* = arc light. *l*<sub>1</sub>, *l*<sub>2</sub> = lenses. *r.l.* = recording lever. *m* = horizontal microscope. *s* = signator.

#### b. Rhythmical activity of the alary muscles

With *Hydrophilus piceus* and with *Lepidoptera*, adults as well as larvae, the movements of the alary muscles could be very nicely observed. They were very demonstrative with the adult *Lymantria dispar* and *Smerinthus ocellata* and with the larva of *Cossus cossus*. The heart segment of these animals showed the two-phased diastole, already observed by Dubuisson and Krey in other species. To be able to compare the amplitudes of the heart and a.m. contractions, we fixed the hook just at the place of attachment between the septum and the heart (fig. 3) and let the preparation incline, so that both parts tore at the same angles. Then their contractions

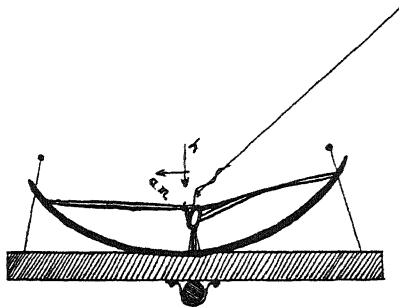


Fig. 3. Scheme of a heart preparation in sloping position to record activity of alary muscles. The preparation is seen in cross-section, showing the dorsal vessel, the septum (fixed at the terga) and the heart suspensory.

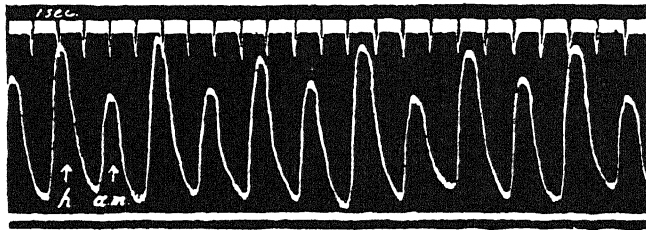


Fig. 4. Heart preparation of *Cossus cossus* (larva). Alternate contractions of heart (h) and alary muscles (a.m.), registered as shown in the scheme of fig. 3. Time reg. 1 sec.

result in a movement of the lever to the same direction, and in each heart cycle a two-topped curve is produced (fig. 4).

We observe:

1. That the contractions of the alary muscles alternate with the heart beat in a perfect synchronism.
2. That the strength of the contractions of the alary muscles is in *Cossus cossus* about  $\frac{3}{4}$  of that of the heart systole.
3. That the contractions of the two parts immediately follow upon each other.

Beside these contractions we observed another rhythmical activity consisting of alternate contractions of the right and left alary muscles of the same segment, as a result of which the heart moves to and from the septum plane. The a.m. of one segment then serve as each other's antagonists (fig. 5).

With the heart of *Cossus cossus* the frequency of these contractions was about  $\frac{1}{2}$ , with *Hydrophilus* about  $\frac{1}{10}$  of that of the heart beat.

#### c. Irritability to electric stimuli

A research into the irritability to induction shocks was made by means of the induction coil *Dubois Raymond*, combined with a 2V.accumulator. A chair-shaped stimulator was used, the electrodes of which were made of 0.1 mm. platin wire. These electrodes were placed on the alary muscles of the registered heart segment.

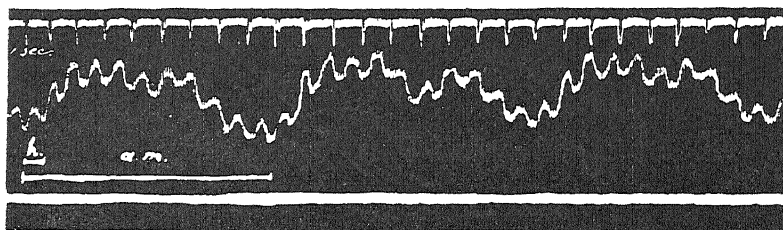


Fig. 5. Heart preparation of *Hydrophilus piccus* (adult). Alternate contractions of right and left alary muscles of one heart segment (large waves, a.m.) and heart pulsations (small waves, h). Hook of the registering lever fastened at the septum above the heart; preparation in horizontal position. In the curve, the upward direction is that of the systole.

The secondary coil was usually parallel with and at a distance of 19 cm. of the primary one. The intensity of the stimulation obtained was such as to prevent interfering effects of slipping currents.

It was again the larva of *Cossus cossus*, in which our efforts succeeded best. As is shown in the curve, stimulation by a short faradic stimulus results in a short contraction of the a.m., causing a diastolic stroke of the lever (fig. 6). If the heart beats strongly,

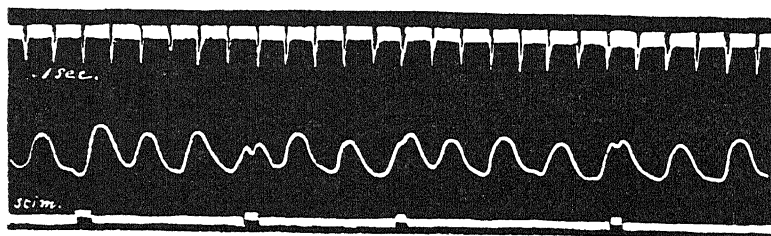


Fig. 6. Heart preparation of *Cossus cossus* (larva). Result of short faradic stimulation of the alary muscles. Registration as in fig. 5.

the result of a tetanic stimulus is only a slight decrease of its amplitude, but if its beats are weak it is arrested by a contraction of the a.m., lasting about twice as long as the stimulus (fig. 7).

#### d. Periodic changes in the contractions of the alary muscles

Especially with the heart of *Hydrophilus piceus* it was clearly visible already under the binocular microscope that periodic changes occur in the depth of the diastole, as is shown in fig. 8. From the fact that the systole is nearly unaltered we conclude that the changes must happen in the contractility of the a.m.

At the moment we can give no explanation of the phenomenon.

#### Summary

Optical registrations of the heart beat of *Hydrophilus piceus* and of several species of Lepidoptera, adult specimen as well as larvae, showed the following phenomena:

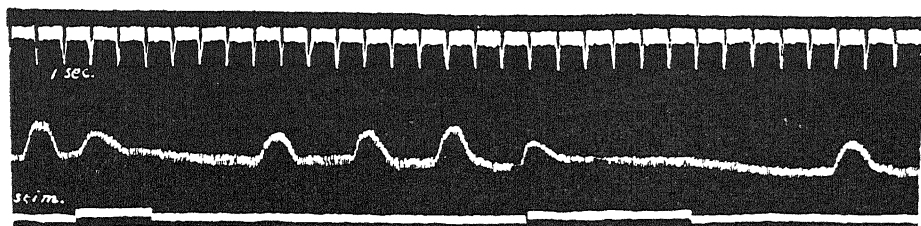


Fig. 7. Heart preparation as in fig. 6. Result of tetanic stimulation of alary muscles. Heart beats weakly. Registration as in fig. 5.

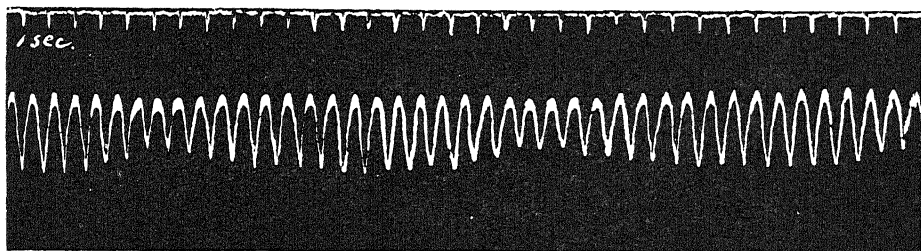


Fig. 8. Heart preparation of *Hydrophilus piceus*. Periodic changes in the contractions of the alary muscles. Registration as in fig. 5.

1. Rhythmical contractions of the alary muscles synchronous with the heart pulsations and of about  $3/4$  of the latter's strength.

2. Alternate contractions of the a.m. of both sides of a heart segment.

Their frequency was about  $1/2$  to  $1/10$  of that of the heart beat.

The irritability of the a.m. to electric stimuli was proved.

With *Dytiscus marginalis* and *Periplaneta americana* contractility of the a.m. could not be demonstrated.

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## THE INVESTIGATION OF THE LEARNING ABILITY OF ANTS

By Derek Wragge Morley

The investigation of ant learning presents many difficulties. Obviously it is important that we should know if some species of ants have more learning ability than others and whether greater learning ability is reflected in greater ecological success or is related in any way to the complexity of the social structure of the community. In some ways even more interesting is the possibility of variation of learning ability between the individual worker of a single community and its relation, if any, to the role which they play in that community.

The primitive ants as represented, for example, by the *Ponerinae* and some of the *Myrmicinae*, show little learning ability and little individual variation in what learning ability they do possess. Indeed there is a close correlation between the growth of the social complexity of the ant colony and the growth of learning ability and consequent

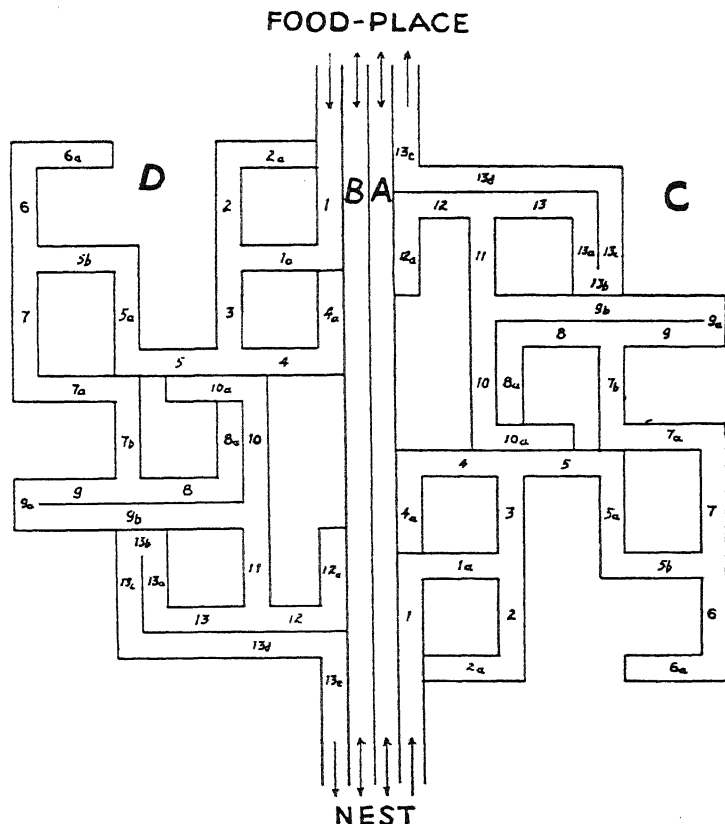
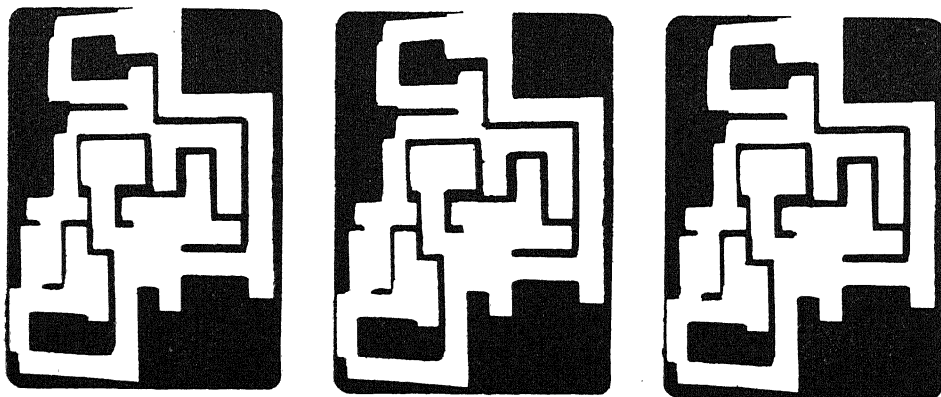


Fig. 1. The first virgin *F. fusc*a queen carrying her eggs. Picture Post ... Photographed by Raymond Kleboe.

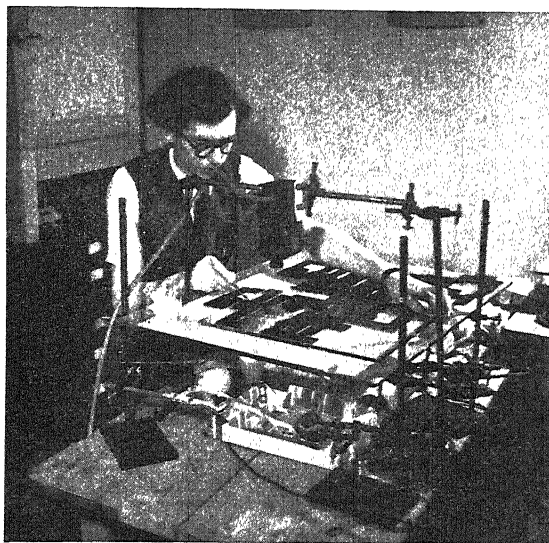
individual variation in behaviour. How do we test ants for their learning ability? T. S. Schneirla made the first experiments in this field, using a fairly complex maze of a similar type to the hedge or wall labyrinths which are found in many European countries. For example those at Hampton Court (England). (See fig. 1.) Unfortunately he never completed his experiments, although they were sufficiently advanced to show the existence of considerable variation in learning ability between individual ants.

The author has for some time been engaged in a series of experiments designed to test the learning ability of individual ants, its relationship to their role in the community (i.e. to the growth and maintenance of the community) and its relationship to the general pattern of inheritance. To what extent is learning ability inherited and how is it inherited? Is it possible to undertake breeding experiments involving genetic selection for learning ability, and will such selection for learning ability leading to the production of ants of greater and greater learning ability enable one to produce a reasoning ant? Is there some barrier which learning ability, however great, cannot pass; in fact are reasoning and learning ability radically different qualities? Yet another aspect of this experimental work with mazes is the examination of neurotic behaviour in ants (See Wragge Morley 1948. *Nature* 162. 74—5), its occurrence and causes. These are some of the questions to which an answer is being sought.

How is this work undertaken? Colonies of ants are selected from different species representative of different stages of evolutionary development and different degrees of social development. These colonies are bred in captivity and the workers are tested for learning ability in a series of mazes (See fig. 2). In these mazes heat, lighting, smell and all the minute variations in the form of the track must be controlled in order that we can be sure that the ant is learning directions as patterns and is not being guided by unknown variations of say form or light in different parts of the maze. Heat and lighting are controlled with electric light and mirrors (See fig. 3). Smell is controlled by washing the maze through with a strongsmelling chemical (usually aniseed oil) before each run. The minute differences of form are controlled by using a series of mazes of the same pattern which will vary in the minor details of form which might otherwise be guiding the ants.



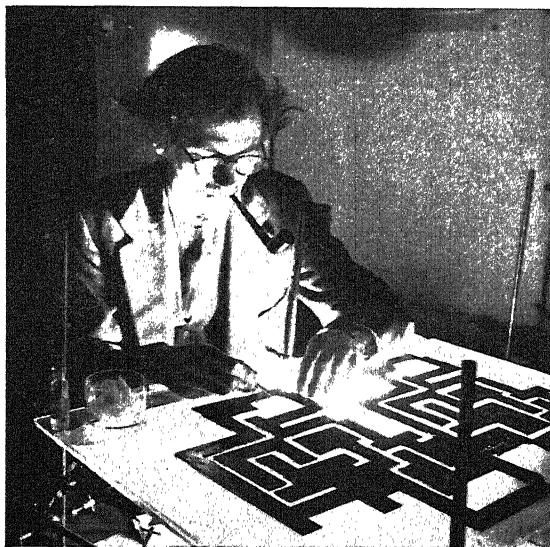
*Fig. 2.*



*Fig. 3. Picture Post. Photographed by Raymond Kleboe.*

Sometimes the ants may be tested in mirror mazes where all the errors of the maze they have just learnt are solutions (see fig. 4), in order to test the persistence of their learning.

The number of runs necessary for an ant to reach the minimum number of errors per run and the lowness of that minimum number, will give an assessment of its maze



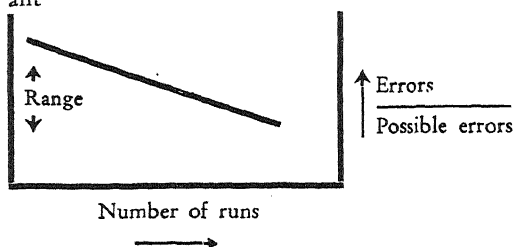
*Fig. 4. Picture Post. Photographed by Raymond Kleboe.*

learning activity. We can then see if this is related to the degree of physical activity exhibited by each individual ant or to the initiation of work-projects undertaken by the community.

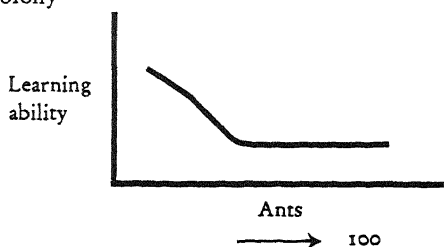
It is possible to measure experimentally the relationship between individual variation in behaviour as determined in maze-learning, and the group reaction to this individual variation.

1) Firstly measure the degree of "individuality" as demonstrated in maze-learning:—

a) For the individual ant



b) For the colony



Take the average to obtain the colony learning ability. Note range to obtain variation.

- 2) Secondly, note the number of ants functioning as "excitement centres" (See Wragge Morley 1946. *Nature* 158. 913.) in the community.
  - 3) Thirdly, note the number of times individual ants serve as "excitement centres".
  - 4) Fourthly, note the number of ants attracted by individual "excitement centres".
  - 5) Fifthly, count the number of ants in the community.
  - 6) Sixthly, measure the spatial relationships of the ants and the community.
  - 7) Seventhly, note the number of contacts between ant and ant in the community.
- Then 2) x average of 3) x average of 4) = the number of ants attracted through "excitement centres" (A). 5), 6), 7) are expressible as contacts per square centimetre per diem—the number of ants in the colony (B). These factors may be examined separately in relation to 1 a) or 1 b) as required, or may be combined with 1 b) (C) as follows:—

$$\frac{A}{\frac{C}{B}}$$

which will give a factor which may be termed

B the group behaviour quotient.

The largeness or smallness of this quotient in colonies of the same or different species will give a reliable measure of the degree of individual variation which occurs in any community and its effect on the general behaviour of that community.

By controlled breeding and selection we can find out if learning ability can be increased or intensified through selected mating. This is possible because males can often be obtained from eggs laid by workers (worker ants are degenerate females, but in general only produce unfertilised eggs which in the ants develop into males) which can then be mated with queen ants of known inheritance. Lately a technique has been discovered which enables offspring to be obtained from virgin queens without the aid of any males, and enables a closer study of inheritance and environmental factors to be made. The inheritance of behaviour factors in different strains can thus be worked out in some detail and breeding directed towards increasing certain elements undertaken.

The results obtained from this work to date are of a more or less preliminary nature, but are of considerable interest:—

1) There seems to be a definite correlation between the development of social complexity and integration and individual learning ability in the ants. The primitive ants live in small communities and exhibit little co-operative behaviour (division of behaviour). They also exhibit poor learning ability and little individual variation in learning ability. The highly developed ants show great complexity in their social behaviour and a well developed division of labour (which, it should be pointed out, is not fundamentally related to the occurrence or non-occurrence of polymorphic castes). The average learning ability is of a much greater order than that of the primitive ants, and there is considerable individual variation in this factor.

2) There appears to be a distinct correlation between "excitement centres" activity and the degree of individual learning ability. The ants which tend most frequently to start off the different operations of the community are in general those which exhibit the greatest individual learning ability.

3) There is a considerable amount of imitation in ant behaviour, but no evidence of teaching. The ant being copied shows no tendency to adapt its own behaviour to the abilities (physical or otherwise) of the imitator.

4) Neurotic behaviour so defined for rats by Maier and other workers would appear to occur in ants, although the degree of similarity needs further investigation. There is some slight evidence for correlation of neurotic behaviour induced in mazes with learning ability, but they may be merely a reflection of the method of induction.

This work is now being undertaken at the Institute of Animal Genetics, Edinburgh University where work on ant embryology and cytology is now being commenced as part of a co-operative scheme of research.

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## SECTION III

NOUVELLES REMARQUES SUR L'ATTRACTION DES ADULTES D'AGRIOTES  
(Col. Elateridae) PAR DES BOTTILLONS DE DIVERSES PLANTES

Par J. d'Aguilar

Des études entreprises depuis quelques années en Bretagne, à Pleyber-Christ (Finistère) sur l'écologie des adultes d'*Agriotes lineatus* L., *obscurus* L., *sputator* L., nous permettent d'apporter des précisions sur les concentrations préférentielles d'adultes sous les bottillons de différentes plantes.

En effet, si certains auteurs avaient déjà signalé l'utilisation pratique des bottillons de tiges feuillées de Trèfle, Luzerne, Haricot ou Graminées, aucun n'avait approfondi les facteurs de telles concentrations.

Dans une note précédente<sup>1</sup> nous avons mis en évidence le groupement préférentiel des adultes sous les bottillons de Trèfle coupés depuis 5 jours, groupement que nous attribuons à la fois à une hygrophilie marquée et à un chimiotactisme.

De nouvelles expériences nous permettent de confirmer qu'un vieillissement des bottillons de Trèfle de quelques jours favorise des groupements plus denses d'adultes pendant les périodes favorables de déplacement, que les bottillons fraîchement coupés. Cette remarque peut aussi s'appliquer aux bottillons des autres plantes sur lesquelles nous avons expérimenté.

Afin de montrer l'action du facteur hygrométrique isolé nous avons placé sur le sol, en compétition avec des bottillons, des "éponges" imbibées d'eau. Les concentrations sous ces dernières furent très faibles et ne furent pas plus importantes que celles des simples abris (planchettes par exemple). D'autre part nous avons mis en compétition un certain nombre de Graminées sauvages et cultivées : Avoine à chapelets (*Arrhenatherum elatior* L.), Dactyle (*Dactylis glomerata* L.), Ray-Grass (*Lolium perenne* L.), Paturin (*Poa annua* L.), Avoine cultivée, Blé, Seigle.

Chacune des espèces végétales était représentée par 2 bottillons de 300 cm carrés chacun, ceux-ci furent répartis à 10 m. l'un de l'autre dans un champ d'Avoine d'hiver d'environ 1 ha.

Voici la répartition des 7.298 adultes capturés du 12 avril au 23 juin 1948, sous les bottillons de différentes Graminées :

Bottillons de	Total <i>Agriotes</i>	<i>A. sputator</i>	<i>A. obscurus</i>	<i>A. lineatus</i>
Avoine cultivée	1.805	682	673	450
Ray-Grass	1.225	523	368	334
Blé	1.129	422	408	299
Dactyle	1.112	435	372	305
Seigle	884	281	395	208
Paturin	589	266	159	164
Avoine à chapelets	554	225	190	139

<sup>1</sup> J. d'Aguilar: Remarques sur le comportement des adultes d'*Agriotes*. C. R. Ac. Sc. T. 226, 1948, pp. 756—758.

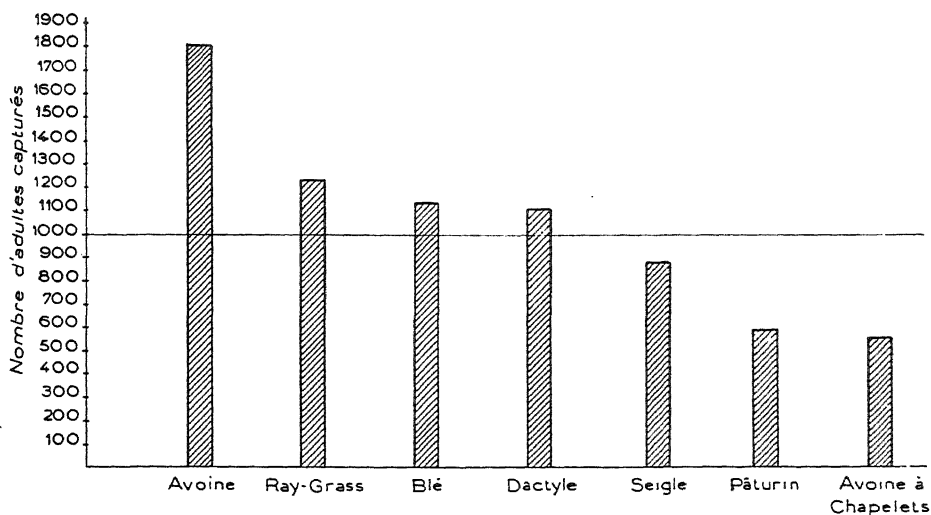


Fig. 1.

L'attraction des différentes plantes expérimentées semble bien être chimique et c'est dans le but de déterminer la substance attractive que nous avons fait des essais avec des poudres de diverses Graminées et de Trèfle obtenues par dessiccation à 100°.

Ces poudres tamisées furent étalées à la surface inférieure d'une éponge artificielle imbibée d'eau.

Dans ce cas, les éponges se comportèrent comme de simples abris.

Ces premières expériences nous amènent donc à penser que la ou les substances attractives sont libérées au cours de la dessiccation naturelle<sup>2</sup>.

Il est enfin utile d'insister sur l'intérêt des " pièges " qui apportent non seulement de nombreuses précisions sur l'écologie des adultes (répartition suivant les cultures, variation de pullulation au cours de l'année et des assolements, groupements préférentiel suivant les régions, etc. . .) mais encore, du point de vue pratique, favorisent les groupements des adultes et leur destruction. En effet, nos propres expériences nous permettent de préciser que des bottillons de Dactyle saupoudrés de produits à base de D. D. T. ou d'H. C. H. continuent d'être attractifs et provoquent aussi la mort des individus qui y sont attirés.

En conclusion, les bottillons de Trèfle et de diverses Graminées sauvages et cultivées (particulièrement Avoine, Dactyle, Ray-Grass) se comportent comme des pièges et favorisent des concentrations importantes d'adultes d'*Agriotes obscurus* L., *lineatus* L., *sputator* L. quelques jours après leur coupe. Le seul facteur hygrométrique est insuffisant pour provoquer des concentrations importantes d'adultes. La ou les substances attractives doivent être libérées au cours de la fermentation ayant lieu pendant la dessiccation naturelle des bottillons. L'attraction n'est pas masquée par la présence de poudres à base de D. D. T. ou de H. C. H.

<sup>2</sup> R. S. Lehman (1932) expérimentant sur des adultes de *Limonijs canus* Lec. et *californicus* Mann. (*Elateridae* d'Amérique du Nord) a remarqué que l'acide butyrique, l'acide caproïque, le pélargonate d'éthyle étaient capables d'attirer ces insectes.

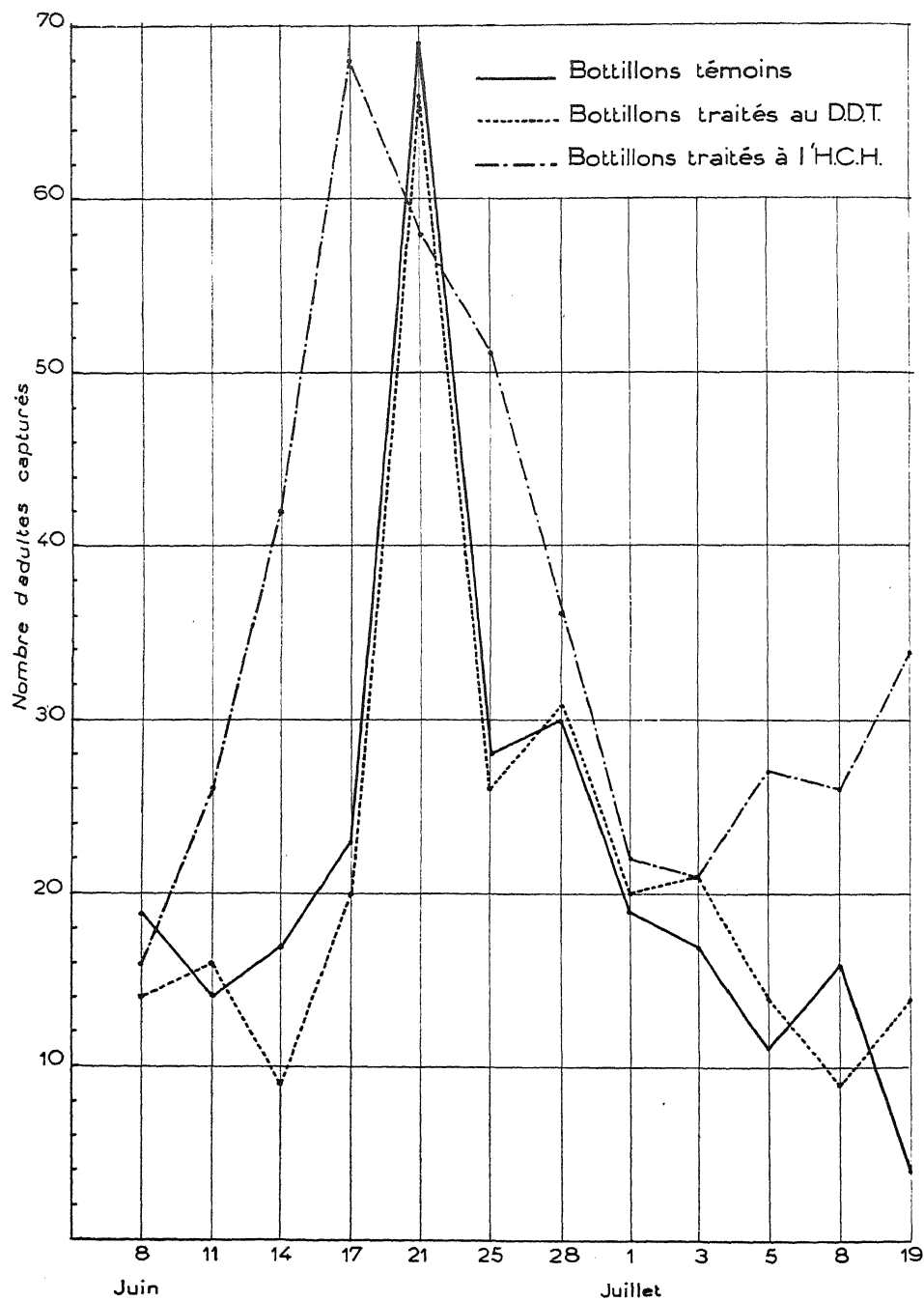


Fig. 2.



## ON THE LIFE-HISTORY OF EPIOPHLEBIA SUPERSTES (ODONATA, ANISOZYGOPTERA)

By Syoziro Asahina

The life-history of the archaic dragonfly, *Epiophlebia superstes* Selys, has been studied by Japanese entomologists, namely Asahina (1934, 1938, 1939), Tokunaga & Odagaki (1939) and others. Together with the recent observations of my own, I will summarize here the present knowledge on the habits of this insect.

In the vicinity of Tokyo the *Transformation* is performed mainly in the last decade of April. The full grown nymphs cling to some plant-stem or rock adjacent to the breeding water. Some nymphs, however, were observed to transform far apart from the water. In May 17th, 1939, I found a nymphal exuvia on a bark of a *Cryptomeria japonica* growing at a distance of 30 feet from the water. The nymphs take whether the vertical or overturned (ventral-side upwards) position, and the emerged adult insects hang vertically, the wings and the abdomen being closed together. Though the transformation naturally takes place in the early morning, in a rainy day it is performed even in the daytime.

*Season of flight* is from the last decade of April to the end of May, but there is an earlier record March 30th from Mt. Wakasugi, Fukuoka Prefecture, Kyusyu. In many localities of mountainous regions they occur generally in June and even as late as in July. In Hokkaido they fly usually in June.

*Flight* is almost confined to the narrow mountain-valley where the nymphs breed. During the earlier days of the season while the dragonflies are still immature, they patrol rather high up in the air, where they prey upon small insects. Such a flight is, therefore, referred to a feeding flight. In a later season when they are mature the same flight is also observed during the early morning before 10 o'clock and in the afternoon later than 3 o'clock on a fine day. In the mid-day the mature dragonflies

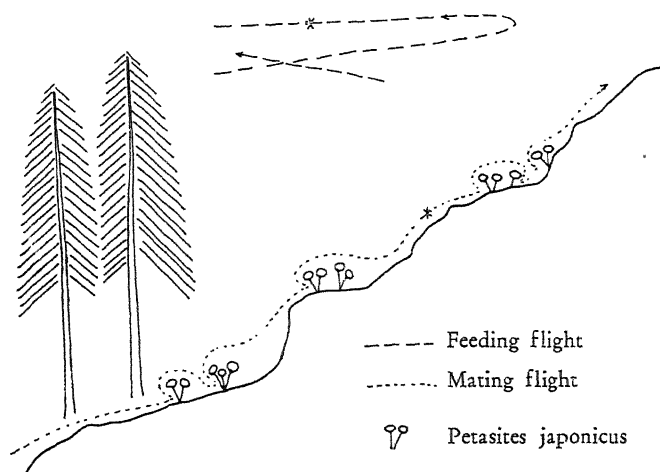


Fig. 1. Flight of *Epiophlebia superstes*. (Original.)

show a characteristic slow flight low down on the brook close to the water. They fly step by step toward the upper stream. This type of flight may be referred to a mating (reproductive) flight. The flight, in general, is very swift with the wings rapidly vibrating, and the insects never make the gliding-flight. The wing-charge was exceptionally greater than any other dragonflies measured. (Tokunaga & Odagaki 1939.)

*Resting-Position* is hanging, and it has been said that during rest the wings are closed like a Zygopterid. But this is not accurate. The dragonflies close the wings tight while they rest for a long period, and for a short time the wings are held half-opened as those of a damselfly of the genus *Lestes*.

*Mating* is ascertained by me for the first time. The male insect grasps the female at her occiput. It is, therefore, the Anisopterid-type. The true copulation, i.e. the transportation of sperm is not yet observed, but it is probably performed by the couples resting on some object. The dragonflies on wing close to the water are almost male, they search there the females which fly among the water-side plants to lay the eggs.

*Oviposition* was also first observed by myself (1934). The eggs were deposited into the soft tissue of the leaf-stem of Japanese coltsfoot (*Petasites japonicus*) by an unaccompanied female. The females cling a suitable leaf-stem just growing in the brook. Eggs are inserted into the plant-tissue one by one from below to above. They are arranged in a regular, waved, continuous line. The plants, into which the oviposition was observed, are:

Compositae, *Petasites japonica*, *Ligularia sibirica*, *L. stenocephala*; Umberiferae, *Angelica polymorpha*, *A. edulis*; Ranunculaceae, *Elastostemma involucratum*; Liliaceae, *Cardiocrinum cordatum*; Araceae, *Arisaema japonicum*. The number of the eggs in one batch is as many as from 100 to 500, rarely up to 1000.

Eggs are buried in plant-tissue with the anterior pole upward just below the each puncture. The egg is nearly sausage-shaped, and very slightly curved. The length ca. 1 mm, the width ca. 0.26 mm. The surface of the anterior portion (so-called cap) is coarse. The micropyles are arranged in a ring, 10—13 in number. Eggs are pale yellowish at first, but soon they become slightly dark. The embryonic development will not be mentioned here. While the eggs develop they swells considerably as in many other insect eggs, and the length of an egg reaches ca. 1.12 mm, width ca. 0.32 mm. In many instances the primary egg-shell has then broken, and a thick, tuff membrane, the secondary egg-shell appears beneath. The period of the embryonic development is about 30 days in 20° C, 20 days in 25.5° C.

In *Hatching* a slit is made to the cephalic end of the egg by the egg-breaker (a longitudinal row of minute teeth) of the head of the pronymph. The pronymph is shrimp-shaped, active creature. They can jump for a distance of 10 cm. Upon

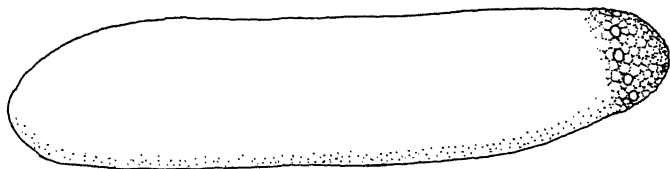


Fig. 2. Egg of *Epiophlebia superstes*. (Original.)

falling to the water, they cast off the pronymphal skin on the water-surface. Then they sink to the bottom.

*Nymph of the first instar* is a translucent creature. When crawl out from the pronymphal skin they are rather odd-shaped with the head abnormally swollen. As soon as they arrive at the bottom, the "cephalic heart" in the anterior end of the fore-gut and the "rectal-ampulla" of the posterior end of the hind-gut start in motion. The fore- and hind-gut are so abnormally extended with water that they occupy almost all the body-cavity excepting the portion of the mid-gut where the remnant of the embryonic yolk is still recognized. In such a state the nymphs lie entirely motionless. Meanwhile the air is introduced into the tracheae, issued from the main tracheal trunk of the thorax. After 25 minutes (in 20° C) the water is suddenly pushed out from the alimentary canal and the body is shortened to about  $\frac{2}{3}$  of the swollen length. Now the body is ca. 1.2 mm long and is flat enough as in ordinary Gomphid nymphs. The respiratory action takes place at the rectal branchial basket.

*Nymphal instars* were estimated to be 14 by Tokunaga & Odagaki. Though the nymphs of the second and fourth instars have not been actually caught, their existence is prospected from the growth-curve. The body of a 1st instar nymph is translucent, but in the 3rd instar it changes pale yellow. The brownish markings appear first in the 5th instar and they become darker with the age. The antenna shows 4-segments at the 7th instar. The wing-sheaths and the female ovipositor-rudiments occur at the 8th instar. In the 11th instar the antenna shows the complete 5 segments and the body-coloration becomes much obscure. The nymph of the 14th (viz. the ultimate) instar is brownish black, 20.7 mm. long. Tokunaga and Odagaki supposed that the duration of the nymphal period would require at least 5 or 6 years and even 7 or 8 years according to the conditions.

*Habits of the nymph* were observed by many authors. Esaki (1929) suggested that the nymph probably belongs to a stenothermal and stenoxymbiotic animal. Really the nymphs, especially the grown ones, live in a torrent adhering to the stone with the

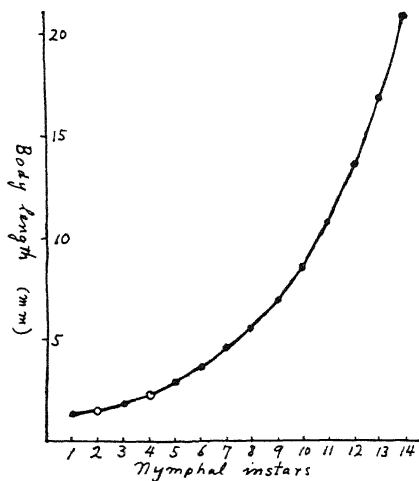


Fig. 3. Growth-curve of the nymph. (From Tokunaga & Odagaki.)

flat ventral body-surface in the rushing water. Furukawa (1934) supposed the setae of the ventral side of the tibiae and the tuft of hairs on the underside of the lateral caudal appendages function as adhesive organs. A nymph moves rather slowly on the legs, but never propels itself by squirting the water out of the hind-gut as is known in the Anisopterid nymphs. I have, however, once observed that a faecal pellet was excreted abruptly from the hind-gut. This would suggest the essential significance of the propulation of water from the nymphal intestine. Tokunaga and Odagaki called attention to the fact that the full grown nymphs leave water of torrent already five months before the transformation. The nymphs, if disturbed, feign death, and make a remarkable stridulating sound with the abdomen and hind femora. The stridulating organ was illustrated by Asahina (1939).

*Natural enemy* is detected in the eggs. A minute Mymarid parasite *Anaphes* sp. was found.



Fig. 4. Geographical distribution of *Epiophlebia superstes*. (Original.)

Distribution of this species is shown in the accompanying map. If we compare this distribution-map with a geological map of this country we can recognize that the majority of the spots falls on rather ancient strata, such as archaeozoic, palaeozoic and, in lesser cases, on mesozoic stratum. On caenozoic and recent volcanic strata the record of distribution is seldom and would be regarded as exceptional. Whether a relation-ship between the relict species *Epiophlebia* and the old geological strata really exist should be studied in the future. An ecological interpretation, however, will be accepted that the environmental conditions provided with good forests and ancient rocks has consequently allowed to survive such a slow-growing primitive insect. I have also tried to search *Epiophlebid* dragonflies outside of Japan. In Sachalin, Okinawa,

Formosa, Korea, northern and eastern Manchuria and Central China, I endeavoured to get the adults, nymphs or eggs, when I had happened to come across a good brook. In every case, however, the efforts have ended in vain.

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## REMARQUES BIOGÉOGRAPHIQUES SUR L'AIRE DE RÉPARTITION MONDIALE DU *G. KERMES* (Hom. Coccoidea)

Par A. Balachowsky

Le genre *Kermes* Boitard forme à lui seul la tribu homogène des *Kermesini* dans la famille des *Lecanoïdæ*<sup>1</sup>. La révision des *Kermes* de la région paléarctique occidentale<sup>2</sup> m'a amené à l'étude biogéographique du genre qui comprend actuellement une quarantaine d'espèces connues réparties dans le monde.

Malheureusement, le statut de nombreuses espèces décrites sommairement et le plus souvent sur des caractères externes ou de coloration de la ♀ adulte est loin d'être précisé. Cette remarque s'applique tout particulièrement aux espèces du nouveau monde, les plus nombreuses, et qui n'ont fait jusqu'ici, l'objet d'aucune révision moderne.

D'autre part, il existe de vastes régions du globe, telles que la Mandchourie, la Chine septentrionale et centrale, riches en *Quercus* indigènes et qui n'ont pas encore été explorées au point de vue coccidologique; il est probable qu'elles renferment de nombreuses espèces inédites de *Kermes*<sup>3</sup>.

Pour toutes ces raisons, la présente étude ne doit être considérée que comme un essai dont les conclusions pourront être modifiées au fur et à mesure que la systématique et la biologie des espèces seront mieux connues.

Tous les *Kermes* sont confinés à la région holarctique, aucune espèce n'a jamais été signalée dans les régions tropicales ni dans l'hémisphère sud.

Ces cochenilles se trouvent donc distribuées dans les zones tempérées et subtropicales de l'hémisphère nord entre les 25° et 60° de lat. N., elles font défaut au-dessus comme au-dessous de cette limite. Cette aire de répartition particulière, s'explique par le fait que les *Kermes* vivent presque exclusivement sur les Chênes qui occupent eux aussi, une distribution géographique sensiblement identique.

Deux espèces seulement ont été signalées au Japon comme vivant en dehors des *Quercus* sur deux autres Fagacées. Ce sont *K. navae* Kuw<sup>4</sup> signalé sur *Castanea pubinervis* (et vivant également sur *Quercus serrata*) ainsi que *K. mutsurensis* Kuw., signalé sur *Pasania edulis*. L'aire de répartition des *Kermes* dans la Paléarctide comme dans la Néarctide ne s'écarte pas des frontières botaniques des *Quercus* spontanés, ces Cochenilles sont prisonnières de cette zone dont elles n'ont pas réussi à s'échapper par "changement d'habitat" et passage sur d'autres plantes, comme c'est le cas pour d'autres Coccoïdæ et de nombreux insectes phytophages.

Cependant, dans cette vaste zone de l'holarctide (voir carte) les *Kermes* n'occupent pas une aire de répartition uniforme, mais forment au contraire des peuplements faunistiques morcelés indépendants les uns des autres et ne s'interpénètrent pas entre eux. On distingue actuellement dans l'aire de répartition mondiale des *Kermes* 5 peuplements faunistiques distincts comprenant chacun des espèces particulières. Ces peuplements peuvent s'établir comme suit :

<sup>1</sup> Balachowsky (A.). Les Cochenilles de France, d'Europe, du Nord de l'Afrique et du Bassin Méditerranéen IV. Classification, p. 254, Herman Edit. Paris 1948.

<sup>2</sup> Voir, p. 344.

<sup>3</sup> *Kermes acaciae* Maskell, décrit de Nouvelle Zélande vivant sur *Acacia*, appartient au g. *Cryptes* Mask., ou *Eulecanium* CKll., mais mon au g. *Kermes* Boitard.

<sup>4</sup> C'est par erreur que *K. navae* a été signalé vivant sur *Rhamnus japonica*, l'espèce vivant sur cette plante étant *Lecanium Kunoensis* Kuw. (cf. Kuwana 1931, p. 28.)

## — RÉGION PALÉARCTIQUE.

1°) *Peuplement euro-sibérien*. Il comprend actuellement 2 espèces : *K. quercus* L. et *K. roboris* F o u r c., vivant exclusivement sur les Chênes à feuilles caduques (*Quercus robur*, *Q. pedunculata*, *Q. cerris*, *Q. pubescens*) qu'elles suivent dans toute leur aire de distribution depuis le nord de la Méditerranée jusqu'au 60° lat. N. à travers le continent européen.

Dans la zone méridionale de cette limite, on ne rencontre guère ces espèces que dans des stations fraîches ou montagnardes où les Chênes à feuilles caduques se trouvent eux-mêmes réfugiés. Elles n'ont pas réussi à s'adapter aux chênes à feuilles persistantes (*Quercus ilex*, *Q. suber*, *Q. coccifera*) ce qui aurait pu étendre loin vers le sud leur aire de distribution. Leur présence n'a jamais été signalée en Afrique du Nord.

2°) *Peuplement méditerranéen*. Il comprend actuellement 6 espèces vivant pour la plupart sur les Chênes à feuilles persistantes (*Q. ilex*, *Q. coccifera*, *Q. suber*) dans le maquis ou la garrigue méditerranéenne. Ces espèces se répartissent en deux sous-peuplements, l'un *méditerranéen* occidental comprenant 3 espèces : *K. vermilio* Planchon, *K. ilicis* L. et *K. bacciformis* Leon.<sup>5</sup> signalées seulement dans les limites du bassin occidental (France méditerranéenne, Italie, Espagne, Afrique du Nord), l'autre *méditerranéen* oriental groupant 3 autres espèces : *K. nahali* Bodh.; *K. greeni* Bodh. et *K. biblicus* Bodh.<sup>6</sup> connues exclusivement jusqu'ici du bassin oriental (Syrie, Palestine).

Les espèces méditerranéennes n'ont pas réussi à s'adapter aux chênes à feuilles caduques (excepté *K. bacciformis* Leon.) et elles n'ont pas pénétré dans les limites de la zone euro-sibérienne.

3°) *Peuplement himalayien*. Représenté actuellement par une seule espèce aberrante lécaniforme, *K. himalayensis* Green découverte par Stebbing à Bhim Tal (N.O. Himalaya) vivant sur *Quercus incana* dans sa station spontanée (Green 1909 p. 10). Pullule dans cette région au point de provoquer le dépérissement des peuplements de chênes. Il est probable qu'il existe d'autres *Kermes* dans cette région riche en *Quercus* spontanés.

4°) *Peuplement nippon*. Il a été fort bien étudié par Kuwana (1931) au Japon qui a décrit 5 espèces de ce pays vivant principalement sur les chênes indigènes, ce sont : *K. navae* Kuw., *K. mutsurensis* Kuw., *K. miyasaki* Kuw., *K. vastus* Kuw. et *K. nakagavae* Kuw.

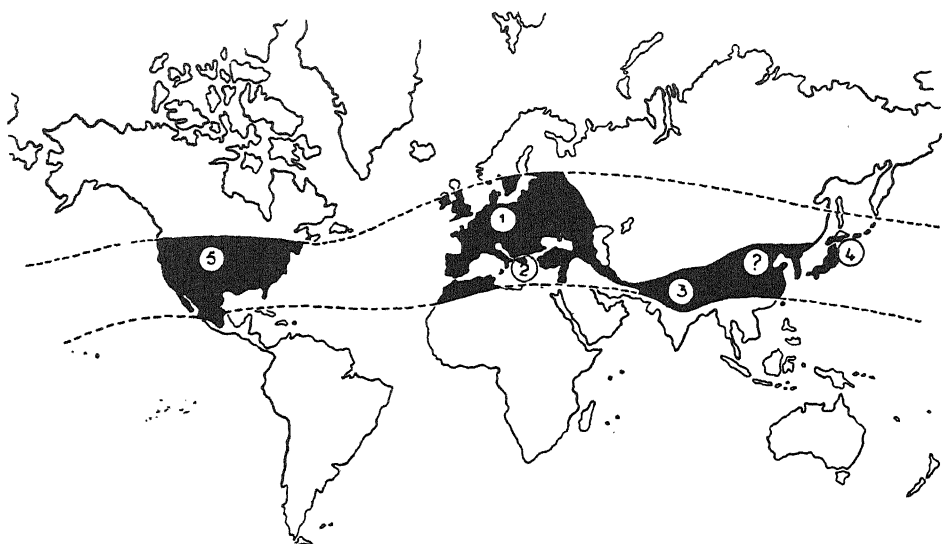
Aucun *Kermes* n'a été signalé jusqu'ici de Mandchourie, de Corée ou de Chine septentrionale, régions remarquables par la diversité et le nombre de leurs chênes spontanés, et par leur grand intérêt biogéographique.

## — RÉGION NÉARCTIQUE.

5°) *Peuplement nord-américain*. L'Amérique du Nord caractérisée par une extrême variété et un nombre élevé de *Quercus* indigènes, forme la région du globe la plus riche en *Kermes*. 29 espèces y ont été signalées et même si ce nombre doit être réduit de quelques unités après la révision systématique des espèces, ce peuplement n'en reste pas moins le plus important du globe.

<sup>5</sup> *K. bacciformis* Leon (v; p. 344) n'est connu pour le moment que par la série type découverte par Leonardi en Italie méridionale où cette cochenille vit sur *Q. cerris*. Ce dernier est un chêne à feuilles persistantes.

<sup>6</sup> Le statut de ces 3 espèces n'est pas définitif, leur description ayant été faite sommairement (Bodenheimer 1931, p. 246) exclusivement sur des formes adultes. La description de *K. biblicus* Bodh. peut également se rapporter à celle de *K. ilicis* L. Nous n'avons malheureusement pas réussi à obtenir les types ou co-types de ces 3 *Kermes*.



Carte montrant l'aire de répartition actuelle des Coccoidea du g. *Kermes* Boitard, dans le monde. (1) peuplement euro-sibérien. (2) peuplement méditerranéen. (3) peuplement himalaïen. (4) peuplement nippon. (5) peuplement néarctique. (?) peuplement présumé coréo-sino-mandchou.

Les espèces actuellement connues de l'Amérique du Nord sont : *K. austini* Ehr., *K. andrei* King., *K. perryi* King., *K. galliformis* Riley., *K. gilletei* Ckll., *K. boguei* Ckll., *K. grandis* Ckll., *K. pubescens* Bogue, *K. concinnulus* Ckll., *K. cockerelli* Ehr., *K. nigropunctatus* Ehr., *K. nivalis* King., *kingii* Ckll., *K. ceriferus* Erh., *K. pettiti* Erh., *K. trinotatus* Bogue, *rattani* Ehr., *shastensis* Ehr., *essigi* King, *mirabilis* King, *waldeni* King, *occidentalis* King, *sassceri* King, *branigani* King, *arizonensis* King, *cueroensis* Ckll., *ehrhorni* Ckll.

La grande majorité de ces espèces est confinée au territoire des Etats Unis; *K. pettiti* Ehr. remonte jusqu'au Canada et *K. grandis* Ckll. pénètre au sud dans la zone néarctique du Mexique. Aucune de ces espèces n'appartient à la faune néotropicale.

Les recherches sur les *Kermes* américains ne sont pas encore suffisamment avancées pour qu'il soit possible d'en dégager une étude biogéographique de détail. Il apparaît cependant que la Néarctide comme la Paléarctide ne possède pas un peuplement uniforme de *Kermes*, mais qu'il existe un certain nombre de groupements faunistiques distincts correspondant aux grandes régions naturelles (atlantique, pacifique, montagnes rocheuses, région sonoriennne etc. . .) formant autant de peuplements indépendants et correspondant ainsi à la figure morcelée de la faune de l'ancien monde.

— CONSIDÉRATIONS GÉNÉRALES ET CONCLUSION. L'étude biogéographique des *Kermes* fait ressortir quelques données biogéographiques importantes à savoir :

1°) Les *Kermes* sont distribués dans la Paléarctide et la Néarctide en peuplements morcelés dans les limites géographiques des Chênes spontanés. Parmi ces faunules quercicoles, les espèces apparaissent pour la plupart comme étroitement spécialisées et vivant



sur une espèce ou un groupe d'espèces affines de Chênes (ex : Espèces des *Quercus* du type *robur*, par opposition aux espèces du type *ilex* etc. . .). Chaque groupement spontané de Chênes possède donc sa faune particulière (Chênes médio-européens, méditerranéens, himalayiens, nippons, nord-américains). Il n'existe pas d'interpénétration faunistique réelle entre ces peuplements malgré certains contacts permanents existant à leur limite géographique (type méditerranéen au contact de types euro-sibériens et vice versa).

2°) L'étude systématique des *Kermes* appartenant aux divers peuplements précités, fait ressortir que ces espèces appartiennent à plusieurs types morphologiques correspondant aux caractères de la larve néonate. On distingue notamment parmi ces larves 4 types morphologiques distincts établis sur la structure et la disposition des épines pluro-dorsales du corps qui peuvent affecter les formes suivantes :

- a) — courtes et côniques (type : *vermilio* Planchon)
- b) — arrondies, courtes et glandiformes (type : *quercus* L.)
- c) — longues et acérées (type : *roboris* Fourc.)
- d) — larges et spatulées (type : *bacciformis* Leon.)

Ces caractères chaetotaxiques s'accompagnent le plus souvent d'autres caractères secondaires (disposition et structure des glandes ventrales, des stigmates, de l'antenne, des pattes etc. . .) caractérisant bien les différents types morphologiques.

Or, on trouve dans les divers peuplements du globe des espèces affines les unes des autres et correspondant aux types morphologiques désignés ci-dessus (a, b, c, d).

C'est ainsi que *K. quercus* L. d'Europe tempérée et septentrionale apparaît comme extrêmement voisin de *K. nakagawae* Kuw. du Japon qui ne paraît être qu'une forme vicariante orientale du premier et aussi de *K. vastus* Kuw. Comme l'a fait déjà ressortir Kuwana (cf. 1931 p. 28) *K. mutsurensis* du Japon s'apparente à *K. bacciformis* Leon. de la Méditerranée occidentale.

*K. roboris* Fourc. d'Europe appartient au même "type morphologique" que *K. ilicis* L. de la Méditerranée, *K. navae* Kuw. du Japon et *K. kingi* Ckli des Etats-Unis, *K. vermilio* Planchon de la Méditerranée appartiennent au même type morphologique que *K. pubescens* King des Etats-Unis. Il est très probable que lorsque la systématique des *Kermes* américains sera mieux connue, d'autres espèces néarctiques apparaîtront comme très voisines de certains types correspondants euro-sibériens, méditerranéens ou nippons.

3°) Ces remarques font ressortir d'ores et déjà que la plante hôte (c'est à dire les *Quercus*) n'est pas intervenue comme facteur sélectif déterminant dans l'évolution des *Kermes* et que l'on ne trouve pas dans chaque peuplement considéré et chaque groupement de Chêne, des espèces aux caractères homogènes ou d'un type morphologique similaire. Il convient donc d'écarter le principe du "host selection" dans l'évolution de ces cochenilles. Il est probable que les *Kermes* étaient beaucoup plus nombreux autrefois et que les lignées appartenant aux différentes souches (a, b, c, d.) peuplaient avec beaucoup plus d'uniformité la grande sylvie ante-glaciaire. Les bouleversements climatiques et les modifications continentales intervenues au cours des glaciations du quaternaire, ont dissocié cette faune en la fractionnant en un certain nombre de peuplements qui ont continué à évoluer *in situ* suivant leurs affinités écologiques. La faune actuelle en est le vivant reflet.

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ANALYSIS OF SOME ELEMENTS OF THE SCOLIID-FAUNA  
OF THE MALAYAN REGION

By J. G. Betrem

I have previously pointed out that the Scoliid-fauna of the Sunda-Shelf (Malaya, Sumatra, Java, Borneo) contains both a Chinese and an Indian element (Betrem 1928, p. 372, and 1936). In these publications the documentation is very short, so that it is desirable to prove this assertion by more data. It is possible to give more details now, because the Scoliid-fauna of China is better known at present, and because I had an opportunity of studying the collections of the Museum Heude at Shanghai some years ago through the courtesy of Dr Piel. Furthermore the Scoliids of Japan are now better known by reason of the work of Professor Uchida of the Hokkaido University.

The systematic category most useful studying the elements of a fauna is the "genre géographique" of Trouessart ("Artenkreis" sensu Rensch). It is, however, very difficult to disentangle the true affinities of the species. Only a very intensive study of the structural characters and of extensive material can produce satisfactory results. Luckily some larger systematic categories have such a characteristic distribution that it is not necessary to split these up in smaller groups.

If we consider the distribution of the groups of Malayan Scoliids which have an area that is sufficiently extensive, we can distinguish three types of distribution.

Type I. Groups which are found in India but not in Central and North China, namely: Subgenus *Campsomeriella* Betr. 1941 (subgenus *Campsomeris* Betrem 1927 and 1928 nec Lepeletier 1845)<sup>1</sup>; group of *Campsomeris phalerata* (Sauss. 1858); subgenus *Microscolia* Betrem 1928; subgenus *Triscolia*, sectio *Megascolia* Betr. 1928; group of *C. (Megacampsomeris) indica* (Sauss. 1854)<sup>2</sup>.

Type II. Groups living in China but not in India except in the Himalayan Mountains and living in the country east of the north south line through Calcutta, namely: those of *Campsomeris (Megacampsomeris) formosensis* Betr. 1928 *C. (Meg.) prismatica* (Sm. 1855), *C. (Meg.) asiatica* (Sauss. 1864), *C. (Sericocampsomeris) quadriguttulata* (Burm. 1853), *C. annulata* (F. 1793); the subgenus *Carinoscolia* Betr. 1927; the groups of *Scolia decorata* Burm. 1854, *Sc. vollenhoveni* Sauss. 1859 ad of *Sc. nobilis* (Sauss. 1858).

Type III. Groups living in central China as well as in India, namely: the subgenera *Liacos* Guér. 1839, *Austroscolia* Betr. 1928; the groups of *Sc. (Triscolia) haemorrhoidalis* F. 1787, *Sc. jurinei* Lep. 1845 and of *Sc. quadripustulata* Lep. 1845.

So there can be no doubt that the groups of type I forms an Indian element in the Malayan fauna and those of type II a Chinese. But how are we to interpret the third type. This is a somewhat difficult problem which can be solved only if we analyse the elements of the first two types.

Type I. Three groups of the subgenus *Campsomeriella* have the most remarkable

<sup>1</sup> In the year 1926 Bequaert fixed as type of the genus *Campsomeris* *C. atrata* (F. 1775), an American species. Betrem not knowing this chose in the year 1927 *C. thoracica* (F. 1787) as type of the same genus. The subgenus to which *C. thoracica* belongs must therefore get a new name for which is chosen *Campsomeriella* Betr. 1941.

<sup>2</sup> *Campsomeris indica* (Sauss. 1854) belongs to the subgenus *Megacampsomeris* Betr. 1928. To the same group belongs *C. snelleni* (Sauss. 1859), the male of which proved to be *C. azurea* (Sauss. 1859) nec Christ 1791.

history and distribution. The group of *C. collaris* (F. 1775) is distributed from South Africa across South Palaearctica to South East Asia, where it reaches the province of Kwantung in the North and Java, the Philipines and the North of Celebes in the East. The group of *C. hirticollis* (F. 1804) occurs only in a small area, namely in Java, Celebes, the Molucas and most of the lesser Sunda Isles. The group of *C. manokwariensis* Cam. 1906 is the most primitive and therefore has a discontinuous distribution. It is found on Formosa (common), the South of Cochin China, Central Sumatra, Celebes, New Guinea (common) and the Eastern Lesser Sunda Islands (Wetter, Timor, probably common). Where the representatives of this group are common, the other two groups do not occur. The first two groups have areas of distribution which almost replace one another, only on Java and on the north of Celebes they are found both. The groups must be considered as three stadia of development and perhaps also as three waves of immigration in the malayan region.

So we can conclude that this subgenus is very old, because it has a very extensive area of distribution.

We come to the same results, if we consider the other subgenera and groups mentioned. The subgenus *Microscolia* occurs also in Africa as Professor Bradley has kindly pointed out to me. The subgenus *Triscolia* is found in South Palaearctica. Only the group of *C. (Megac.) indica* has a limited distribution, which is probably very modern, because the species has progressive characters.

Type II. The groups with this type of distribution we find on the Sunda Shelf and eastwards as far as the Philippines and Celebes. Further to the east they have only very remote relatives. It is remarkable that the species with primitive characters, which have this type of distribution, are found in the tropics mostly on the mountains (on Java above 800 m a.s.). At lower altitudes more modern groups have been developed, e.g. the groups of *C. asiatica* and *C. habrocoma* (Smith 1855), the first of which occurs in the mountains, the second in the lowlands. None of these groups is known as yet from Africa, the South of Palaearctica or from India. Only *C. ceylonica* (K. 1889), which is known from Ceylon, forms an exception.

Type III. The subgenera *Liacos*, *Austroscolia* occur in Africa according to informations kindly given to me by Professor J. Ch. Bradley, while *Triscolia* is known from South Palaearctica. Forms allied to each of these exist in the Moluccas and New Guinea. In East Asia none of these groups have reached Japan. Since the group of *Sc. jurinei* has only a restricted distribution, nothing is known about its geographical affinities. The group of *Sc. quadripustulata* is probably very young because it has not yet reached Sumatra and Borneo, so it must have populated Malaya after the time the sea had flooded the Sunda Shelf.

From the known facts we can draw the following conclusions.

1. There are existing many groups of species which are characterised by a very extensive distribution of the group and their near relatives, mostly from Africa or South Palaearctica through India as far as New Guinea. Therefore we call this part of the malayan fauna the indian element. Many of the groups belonging to this division have primitive characters e. g. three cubital cells or a second recurrent nervure (*Liacos*).

Without much speculation we can therefore consider the indian element as old. Probably we can split up this element in three parts which must be considered as just so many invasions and development-stadia. These three invasions are especially distinct in three groups of the subgenus *Campsomeriella* and probably also in the group of *Campsomeris phalerata* and its allies.

2. There exists a second division of species-groups which are distributed from central China and Japan as far as the Philippines and Celebes. In the eastern parts of the Indian Archipelago only very remoted allied species occur.

In accordance with its smaller area of distribution this element which we will call the chinese element in the malayan fauna, must be of a younger date than the elder invasion of the indian element. In the former probably two parts can be distinguished. One has more primitive characters and in the tropics is now living only on the mountains; the other has more progressive characters and lives in the lower regions.

3. Finally there is the group of *Scolia quadripustulata* which has not reached the larger Sunda Islands. Its distribution must therefore be very recent.

So we can distinguish three evident waves of immigration: 1. the first brought the oldest indian element of the malayan fauna, 2. the second brought the chinese elements and came to the Sunda Shelf probably during a colder period!, 3. the third again brought indian elements, while the chinese elements adapted oneself more or less to the warmer climate. It is possible that some new chinese elements immigrated contemporarily.

It is very important to know in which geological times the successive waves penetrated the Sunda Shelf. This immigration would have been possible during the period in which—because of the low sealevel—the islands Sumatra, Borneo and Java are known to have been united by land with Malaya, while Celebes had a narrow connection with Borneo by the Philippines in the North and with Java in the South.

A more exact dating of the different migration-waves is only possible by comparing the fossil-faunae of Java and their composition. Königswald (1940) distinguishes the following successive faunae: 1. *Tji Dolang*, 2. *Kali Glagah*, both pliocene, 3. *Djetis*, old pleistocene, 4. *Trinil*, middle pleistocene, 5. *Ngandong*, upper pleistocene. In the Tji Dolang fauna fossils are found which are typical for the Sivalik-fauna of India. He names this fauna the siva-malayan fauna. Probably this one is identical with our oldest immigration-wave of the indomalayan element. The chinese element appears for the first time in the Djetis-fauna and remained in the Trinil-fauna. This chinese-element is very important for many reasons e.g. the Java-man (*Pithecantropus erectus* Dubois.) belongs to it. He is the contemporary of the Peiping-man (*Pithecantropus erectus pekinensis* Black) who is now considered as a subspecies of the Java-man. Also the orangutan and the tapir are outstanding forms of this element.

Königswald considers the chino-malayan element as having penetrated the indomalayan region through Formosa and the Philippines, the so-called Luzon track, following therein van Steenis (1935); compare too Lam (1945). I have still earlier pointed out (Betrem 1928, p. 257), that the Scoliid-fauna does not give any indication for the existence of such connection.

We can now describe the history of the immigration in the malayan region as follows: During the last part of the pliocene a Scoliid-fauna (having many affinities to faunae now living further westwards) immigrated from India. An immigration of Chinese elements at that time was probably impossible because the temperature in the South of China was too high. After the beginning of the pleistocene the temperature became lower and therefore the Chinese fauna could penetrate the Malayan region. (The fauna wandered with the climate!). The Indian elements adapted themselves partly to the cooler climate and altered in a progressive way. Later on when the climate became warmer some of the species survived only on the higher mountains, other adapted themselves to the higher temperature and were again slightly altered (mostly

modern forms). Some Indian species penetrated into the Chinese region, when the climate there became warmer. It is probable that during the cooler period some Chinese groups also penetrated into India, but of these only very few remnants now exist for example *Campsomeris ceylonica* in Ceylon.

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THE GEOGRAPHICAL AND ECOLOGICAL DISTRIBUTION OF SOME  
NEOTROPICAL SPECIES OF DIATRAEA GUILD. (LEP., PYRAL.)  
AND CERTAIN OF THEIR PARASITES

By Harold E. Box

The genus *Diatraea* Guilding, of the Pyralid subfamily Crambinae, comprises more than fifty species, and, as today recognised (Tams, 1942) its geographical distribution is limited to continental America and the West Indies. The larvae, except for a few known to inhabit Cyperaceae and Typhaceae, are borers in the stalks of various Gramineae, and those of several species have developed into major pests of sugar-cane (*Saccharum officinarum*), Indian corn or maize (*Zea mays*), rice (*Oryza sativa*) and other cultivated plants of this family. The best known among these "borers" is the genotype, *D. saccharalis*, the various stages of which were described and figured, under the name *Phalaena saccharalis*, by the great Danish entomologist, Johann Christian Fabricius, in 1794, as an extremely serious pest of sugar-cane in the Danish West Indies. It is now known to occur in all countries from the southern United States, through Central America, the Antilles, and South America to the province of Buenos Aires. The original habitat of *D. saccharalis* was discovered by the late Dr. J. G. Myers in the course of his ecological explorations in tropical America during the years 1929 to 1934, and shown to be certain aquatic and riparian grass associations; and from these primitive sources the insect has spread during the last four centuries, to invade vast areas of cultivated sugar-cane and corn, causing very serious losses annually, especially to the sugar industry. It is probable that the species is indigenous in all the regions affected by it, except Louisiana (U. S. A.), where it became established around 1850, possibly from accidental introductions in sugar-canes from Cuba. If this was the case, it is interesting that *D. saccharalis* readily attacks corn in Louisiana, whereas according to Mr. L. C. Scaramuzza (*in litt.*) this plant is not attacked by *saccharalis* in Cuba, where the common corn borer is *D. lineolata* (Walk.).

Within the territory inhabited by *D. saccharalis*, extending approximately from latitude 30° N. to 30° S., there occur several other species of *Diatraea* which have, in similar manner, become agricultural pests, while others have remained confined to their wild host-plants. The range of some of the former is extending year by year, one of the most outstanding examples being *D. grandiosella* Dyar, which has spread within the last few decades from Mexico and Arizona, through the south-western United States, and has now reached Kansas, where it is a major pest of corn.

In certain cases, however, the apparent extension in geographical range is due simply to increased knowledge of the insect's distribution, as, for example, our recent discovery of *D. canella* Hamps. in the extreme west of Venezuela close to the frontier with Colombia. This species was hitherto believed to be limited to the Guianas, north-eastern Venezuela, Trinidad, and certain of the lesser Antilles (excluding Barbados). *D. canella* is an important sugar-cane borer in most parts of its range. Its primitive habitat was shown by Myers to be certain savannah-grass associations, where it was found by him, after considerable search, in the hinterland of British Guiana.

Second only to *saccharalis* in the extent of its geographical range, is *D. lineolata* (Walk.), described in 1856 from Venezuela, and now known in the Bahamas, Cuba,

Grenada, Tobago, Trinidad, Mexico, Central America, and most of equatorial South America north of the River Amazon. Its absence from Jamaica, Hispaniola, Puerto Rico and the Lesser Antilles north of Grenada, is noteworthy. The larva is a destructive borer in corn, and has also been found in Teosinte (*Euchlaena mexicana*), and quite recently in Guatemala Grass (*Tripsacum laxum*). *D. lineolata* is unknown in any truly wild food-plant, and Myers classified it as a "domestic" species which may have developed alongside its cultivated host-plant (*Zea mays*), likewise unknown in the wild state. It is significant that *Zea*, *Euchlaena*, and *Tripsacum* are all members of the small tribe Tripsaceae, which agrostologists consider to be the highest development in the Gramineae, while *D. lineolata* and its immediate allies are apparently at or near the top of the *Diatraea* family tree.

It is interesting to contrast the restricted ecological status of *D. lineolata*, which appears to be confined to cultivated hosts, with that of a species which I regard as one of the most ancestral in the genus, whose larva has recently been discovered in the course of our work in Venezuela. This is *D. pedibarbata* Dyar, which inhabits the thick pithy stalks of *Panicum grande* and *Typha angustifolia*, both of which are aquatic and grow under conditions which cannot have changed greatly since primitive times. These two plants belong to un-related families, and we have here an instance where the similarity of the habitat would appear to be of more importance to the insect than the botanical affinity of the host-plants. It is to be noted that *D. pedibarbata* has not been found in any cultivated plant, although sugar-cane and corn occur abundantly in the vicinities where the larvae were found. The closely allied *D. maritima* Box breeds in *Spartina patens* on the coastlands of British Guiana, but does not seem to have invaded nearby rice-fields.

A striking case where a widely distributed species has become an agricultural pest only in certain restricted regions, is that of *D. impersonatella* (Walk.). This insect occurs in Argentina, Brazil, the Guianas, Venezuela, and Trinidad. A number of wild grass hosts are known, and Myers showed the primitive habitat to be riparian grass associations dominated by *Paspalum fasciculatum*. In British Guiana, this borer is rarely found in the canefields, being a minor pest in the strictest sense, but it occurs quite commonly in *Paspalum virgatum*, a weed grass of the canefield banks and adjacent wet savannahs. In Trinidad, *D. impersonatella* is the most abundant and widespread borer in sugar-cane, and ranks among the major pests of that island. In Venezuela it has a wide distribution, ranging over several thousand square kilometers in the northern and central States, but only in Lara State has it been found in sugar-cane. In the extensive but relatively isolated cane-growing areas in the valley of the river Tocuyo, this borer occurs frequently, in company with other species of *Diatraea*, and sometimes causes considerable damage. Elsewhere in Venezuela, *D. impersonatella* has been found only in will grasses, even where these are adjacent to sugar-cane fields.<sup>1</sup>

It is now necessary to mention an important economic species of northern South America, which has only quite recently begun to receive serious attention. This is *D. busckella* Dyar & Heinr., and it is the only member of the genus yet known with defined subspecies.

During 1926—1927 I found the dominant borer in sugar-cane in the States of Miranda, Aragua, and Carabobo, in northern Venezuela, to yield moths very distinct

<sup>1</sup> My colleague, Signor Pietro Guagliumi, communicates that he has recently found this borer in sugar-cane in Sucre State in eastern Venezuela.



from any others known to me at the time, these having the fore wings of a characteristic *pinkish*, rather than yellowish or brownish, colour. They were provisionally identified as a new species by the late Dr. Harrison G. Dyar, but were received at Washington too late for inclusion in the Revision by Dyar and Heinrich which was about to be published.

In 1930 (Box, 1931) I identified these moths, with some others from Carabobo State reared from larvae in sugar-cane by Mr. H. Osborn, as *D. busckella* Dyar & Heinr., described in 1927 from Porto Bello, Panama, but nothing was given in the description concerning the larva or its food-plant. My determination was based on the original description and figures of *D. busckella*. In 1931, Heinrich separated this pinkish form from Venezuela as a new variety with the name *D. busckella* var. *rosa*, citing Carabobo State as the type locality. In 1934, Dr. Myers sent me specimens reared from larvae which were causing very severe damage to sugar-cane at Santa Marta, Colombia. These moths, however, were *yellowish*, without any pinkish shade, and agreed in every way with typical *busckella* as described from Panama, and were thus referred to in my 1935 paper. It became clear that both forms of the species were important sugar-cane borers during their larval stages.

On my return to Venezuela two years ago, a comprehensive survey was begun, to determine the distribution and ecological status of the various *Diatraea* species injurious to sugar-cane and other crops in that country. Typical *D. busckella* was found to be the dominant sugar-cane borer in the western States of Zulia, Táchira, Mérida, Trujillo, Lara, and western Yaracuy, with an altitudinal range from sea-level to nearly 1,700 meters. The form described as variety *rosa*, which I now (Box, 1948) consider to be a subspecies, appears to be endemic in Venezuela, occurring in eastern Yaracuy, Cojedes, Carabobo, Aragua and Miranda States. It was found last year by Dr. F. Fernández Yépez in sugar-cane in Apure State, not very distant from where Myers had discovered the larvae in tall-grass (*Paspalum fasciculatum*) savannah bordering the Apure and Portuguesa rivers seventeen years ago, this being our only record to date of either form in a wild host in a primitive habitat. So far as our investigations have shown, there is no overlapping in the geographical ranges of *D. busckella busckella* and *D. busckella rosa*, yet the two subspecies approach one another to within less than 20 kilometers in Yaracuy State, with no recognisable ecological barrier intervening.

Within the combined range of these two subspecies there occurs a third which I am about to describe as new. It appears to be confined to a wild habitat, though not a primitive one, and is not known to attack any cultivated host plant. It feeds in the forest-grasses, *Setaria paniculifera* and *S. vulpiseta*, and in Venezuela appears to occupy the niche occupied by *D. bellifactella* Dyar in *S. Poirietiana* in Trinidad.

The various species of *Diatraea* are attacked, in different parts of their range, by a formidable number of hymenopterous, dipterous, and other parasites, which destroy their eggs, larvae, or pupae, and by numerous predators. Some of the parasites have been studied intensively and utilised successfully in controlling *D. saccharalis* in British Guiana and some of the West Indian islands. The present discussion concerns only the dipterous parasites, some of which are obligatory on certain *Diatraea* species, while others are less selective in their choice of hosts.

The tachinid, *Lixophaga diatraeae* (Townsend) native to the Greater Antilles, which was successfully introduced from Cuba to the Leeward Islands in 1932, is a specific parasite of *D. saccharalis*, and attempts to rear it on other borers have so far failed.

The reaction of *Lixophaga* to its host in the field, however, was far from uniform in the different islands where it was introduced, for in St. Kitts it established immediately and brought about complete commercial control of the cane borer, whereas in Antigua ten years of continued artificial rearing were required before this parasite was able to breed unaided in the canefields. In St. Lucia, *Lixophaga* was introduced in 1934; it multiplied rapidly in some localities, but soon died out despite an abundance of its normal host. In Barbados, Mr. Tucker states that he was unable to obtain any recoveries whatever, after an elaborate campaign of rearing and liberating *Lixophaga* in promising fields. In Louisiana, where the parasite was introduced from Cuba by Holloway and his colleagues as early as 1915, it proved itself able to survive the winter, during which the host hibernates as a larva, but it failed to establish permanently.

Whereas variations in local climatic conditions might explain some of these results, the possibility cannot be excluded that this highly specific parasite was unable to breed continuously on what may prove to be localized "biological races" or "eco-subspecies" of the host which have developed a degree of endemism, and which cannot be recognised by orthodox taxonomic methods, but only by their reactions.

The well-known "Amazon Fly" (*Metagonistylum minense* Towns.)—the discovery of which in its primitive habitat on the River Amazon, and its successful introduction to the canefields of British Guiana by Myers in 1932 was a veritable epic in the history of Biological Control—is less specific than *Lixophaga*, and in its original home was found to attack not only *D. saccharalis*, but also other borers of this genus. In British Guiana, however, Mr. Cleare was able to rear only a small percentage to maturity when the parasite larvae were placed on *D. canella*, and in St. Lucia, where the Amazon Fly was a spectacular success against *saccharalis*, it rarely attacked *canella* in the field. In Trinidad, Barbados and Antigua, where this parasite was given extensive trials, it failed to attack *saccharalis* in the field, although large numbers were liberated under apparently ideal conditions, including (in Antigua) beds of *Echinochloa polystachya*, one of the grasses in which it was originally found on the Amazon. In Cuba, Louisiana and Florida, the Amazon Fly failed to become established; in Puerto Rico it established temporarily only in some districts, but does not appear to have effected any marked degree of control over *D. saccharalis*.

In the region of Sao Paulo, in southern Brazil, Dr. Harland reported a melanic variant of *Metagonistylum minense*, adapted to canefield conditions with low rainfall, which has become known as the "dry area strain." It has been tried out in various West Indian islands and the United States, and in Barbados was successfully crossed with the Amazon strain, but it does not seem to have established permanently anywhere. The Amazon strain, adapted by nature to the humid forest region of equatorial Brazil, rapidly established on *D. saccharalis* on the dry windswept Vieux Fort district on the south of St. Lucia.

The Dexiid, *Leskiopalpus* (*Stomatodexia*) *diadema* (Wied.) attacks *D. saccharalis* and other borers in Brazil, British Guiana, Trinidad and Venezuela, but is very localised and seldom abundant. Myers showed that when populations of *saccharalis* in water-grasses on the River Amazon were favourable for attack by *Metagonistylum* they were unsuitable for *Leskiopalpus*, and *vice versa*. This suggests that *Leskiopalpus* might be worth trying in some of the regions where the Amazon Fly has failed.

The most important and widely distributed larval parasite of *Diatraea*, however,

is the fly *Paratheresia claripalpis* V. d. Wulp. I refer to this parasite as one species<sup>2</sup>, and believe that the various forms recognized as species by the late Dr. Townsend will eventually prove to represent no more than biological races, or, in some cases, subspecies. The peculiar host-relations of the insect in parts of its range supports the view that some of these indeterminate forms may be recognized more by their distribution and selection of hosts than by manifest morphological characters in the adults.

*Paratheresia claripalpis* (as here understood) is indigenous in Trinidad and the South American continent, where it occurs from Venezuela south to Peru and Argentina. In British Guiana (where it is known only on certain plantations on the banks of the River Demerara), Brazil, Peru, and Argentina, it has been studied only as a parasite of *D. saccharalis*, and its reaction to other borers in those countries is unknown. In Trinidad, *Paratheresia* attacks the sugar-cane borers, *D. saccharalis*, *D. impersonatella*, and (rarely) *D. canella*; the preferred host is *saccharalis*. An investigator in Trinidad (Kevan, 1943) has produced satisfactory evidence that *P. claripalpis* does not readily attack *D. lineolata* in Trinidad, and Scaramuzza records that he was unable to rear the Trinidad strain on *D. lineolata* when it was introduced into Cuba. He states that "Even when the maggots of this parasite succeeded in penetrating the larva (of *D. lineolata*), and attached themselves to the trachea, none developed farther than the first stage."

In Venezuela, on the other hand, our investigations have shown that *Paratheresia* is distributed wherever *Diatraea* occurs, from sea-level to nearly 1,700 meters altitude, and that it regularly breeds on all of our economic species of borers, including *D. lineolata* in corn, which may sometimes be parasitised up to nearly 100 per cent, in local populations. There appear to be no obvious characters by which the parasites reared from different hosts can be recognized, and neither have I observed any differences between long series from Venezuela and Trinidad. I have recommended that *Paratheresia* be given further trial in Cuba, using the Venezuelan strain, and also suggested that it might be utilized in Kansas against *D. grandiosella*, a corn borer closely allied to *lineolata*.

The careful genetical work of Harland and Atteck, with strains of the egg-parasite, *Trichogramma minutum* Riley, from various lepidopterous hosts (including *Diatraea saccharalis*) brought from different West Indian islands, demonstrated the existence of marked biological races, distinguishable by their reactions to the hosts. The present paper offers evidence that such ultra-taxonomic forms or eco-species may occur in the dipterous parasites of the larvae and perhaps also in the host insects themselves.

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<sup>2</sup> Since this paper was written, Dr. F. I. van Emden, working in collaboration with Dr. C. W. Sabrosky, has published a taxonomic study of *Paratheresia claripalpis* (Wulp) and allied species (1949: Rev. Ent., Rio de Janeiro, 20: 499—508, figs. 1—5).

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## THE ETHIOPIAN SCOLIIDAE

By J. Chester Bradley

Dr. J. G. Betrem has demonstrated that the cosmopolitan genera *Campsomeris* and *Scolia* are distinguishable by structure of the male genitalia, of the mesopleura, of the tergal vestiture, and in other readily appreciable ways, but that a second recurrent vein is not always present in *Campsomeris*, so that while its presence as a complete free vein is a certain indication of *Campsomeris*, its absence is only a presumptive indication of *Scolia*. In the subgenus *Liacos* of the latter it is however present but stalked on the first.

Both of these genera are abundantly represented in Africa, but *Campsomeris*, the more primitive, is less diversified than *Scolia*, just the reverse of the condition in the Neotropical Region.

A third genus, *Campsoscolia*, has recently been wisely erected by Dr. Betrem and it is ancestral to all others. It is represented in Palearctic Africa, and has previously been confused with the subgenus *Trielis* of *Campsomeris*. Whether any of the Ethiopian *Campsomeris* with three submarginal cells really belong to it has not as yet been determined.

There remains a fourth, peculiarly specialized, genus which has not been recognized, and to which I apply the name *Betremia* in recognition of the fundamental taxonomic work of Dr. Betrem on this family.

The most spectacular character of *Betremia* lies in the dense cushion of erect setae, the tip of each one of which is fimbriate, that covers the squarely truncate apex of the propodeum and against which the equally heavily cushioned anterior face of the first tergite fits. But the genus has also other remarkable characters. The lateral carina of the propodeum, present in all other genera, is entirely wanting; the mesopleura are rounded, their upper part not forming such a lobe as in *Scolia*, and the metasternum is broadly emarginate behind, each side produced as a pointed process that projects over the base of one of the hind coxae; the basal abdominal segment dorsally, laterally and ventrally is impunctate and polished, and the second is like it except for its lateral and apical margins. The setae of the pygidium are erect, similar to those of the preceding segments. The venation is as in *Scolia*.

*Scolia apicipennis* Turner is the type of this extraordinary genus, and there are two undescribed species known to me, all apparently of great rarity, all from tropical Africa.

Dr. Betrem has shown that the genus *Scolia* in the Indo-Australian Region consists of several subgeneric groups, natural phylogenetic units, based upon good morphological characters. In addition to the cosmopolitan *Scolia sensu strictu*, three of these also occur in Africa, and two others that are endemic occur there also.

*Liacos* is the most primitive subgenus, in that it retains a second recurrent vein, but displaced and arising from the first, and in the fact that the males are less different from the females than in other subgenera. The peculiarities of the ♂ genitalia and the conformation of the front are shared with the oriental species, but the African forms belong to their own species-group, with distinctive color pattern, and agreeing with the African (but not oriental) members of the second subgenus, *Austroscolia*, in having the sides of the posterior part of the propodeum drawn out into lobes that extend

well beyond the insertion of the petiole. There are three species on the mainland, two of which are undescribed, and one in Madagascar.

The males of both the oriental and Ethiopian species of the subgenus *Austroscolia* are recognizable by the conformation of the front, but the genitalic characters indicated by Betrem do not apply to the African species nor to all of the oriental ones. The three mainland species form a group that agrees with the Ethiopian *Liacos* in the lobing of the propodeum, as already mentioned, and with the third subgenus, but the single Malagasy species has a different color pattern and a simple propodeum comparable to that of the oriental forms.

In the third but as yet undescribed subgenus, the propodeum is lobed as in the continental *Austroscolia* and *Liacos*, the venation is as in *Scolia*, the conformation of the front of the ♀ is as in *Liacos*, but of the ♂ as in *Scolia*. There are three species, all continental, all black, with dark wings and black vestiture except that the last 3 or 4 abdominal segments are red and covered with fiery bristles, a colorpattern shared by some species of the subgenus *Scolia*.

The fourth subgenus is *Microscolia*. The two Ethiopian species, both continental, and rare, are readily recognized by their huge head and short very transverse clypeus, but they lack the peculiar pleural punctuation of the oriental forms. As the males have not been discovered, it remains to be determined whether they have the genitalic peculiarities of the oriental species.

The fifth subgenus is confined to Madagascar and has not been described. There are two species, and the male genitalia differ from all others in having the laminae volsellares lying on the ventral surface of the volsellae; they are also distinguished by the long and narrow basal abdominal segment.

The subgenus *Scolia* contains the bulk of the species of the genus. They are not in all cases easily limited or defined, but appear to break up into regional subspecies that vary in color less than has been supposed.

As nearly all determinations of African Scoliidae during the past 85 years have been based on the work of Saussure and Sichel, and as these authors were entirely misled in regard to the significance of color, completely failed to observe significant structural characters, and misinterpreted the species to which a number of older names had been applied, the result is that the names applied in existing collections and literature are entirely unreliable. I add this as a necessary warning to students of the African fauna, but will conclude with the more encouraging note that prewar opportunity to study nearly all types, as well as extensive material from nearly all parts of Africa have resulted in a series of manuscripts now well advanced towards readiness for press, that it is believed will make the beginning towards a more definite differentiation and geographical limitation of the numerous populations, specific and otherwise.

In the course of this work a few generalities have been noted that may be of interest: Variations of color are usually characteristic of local populations, and this may become more evident as extensive highly localized collecting accumulates. Hue of reflection in the wings is not only usually regional within a species, but is characteristic of great regions regardless of species. Thus species and subspecies from the Guinea Region tend to have brilliantly green, or golden, or coppery reflections, those from east-central Africa green-blue reflections, and those from South Africa purplish reflection; there are of course exceptions.

I cannot conclude without reference to the extraordinary conditions occurring within the Rassenkreis *Campsomeris thoracica*, which will be more fully detailed at another time. This group has reached a complete color differentiation between the sexes, and there is in addition a geographic differentiation of color of body, vestiture and wings in each sex. But the latter has not kept pace between the sexes in different areas. The result has been approximately that of three geographical color types of male and three different geographical color-types of female. Each male or female types goes with one color-type of the other sex in one region but a different one in another, which introduces a very difficult and unusual problem in subspecific nomenclature.

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## THE BEETLE FAUNA OF TRISTAN DA CUNHA

By *Per Brinck*

The Tristan da Cunha group of islands is one of the most isolated pieces of land on the globe. It is situated in the southern parts of the Atlantic Ocean, just north of the Subantarctic region. From Tristan to the nearest point on the African continent there is 2900 kilometres and to that of the South American continent 3200 kilometres.

The knowledge of the beetle fauna of the Tristan group has up til now been very fragmentary. Several expeditions visited the islands, but mostly they stayed for some days only, and insects were collected very rarely. Beetle material from these islands has been studied previously only once. Waterhouse (1884) thus made the scientific examination of the material, collected by the naturalists of the *Challenger* expedition, which visited Tristan in October 1873. According to him, 6 species had been found.

These facts made it the more interesting for me to study the material brought together by the members of the "Norwegian Scientific Expedition to Tristan da Cunha" in the years 1937—1938. Details will be published soon. Here I am only going to present some of the most interesting results of the investigation.

The following species are present in the material:

## FAM. DYTISCIDAE.

*Bidessonotus (Liodesuss) involucer* n. sp.

*Lanceres varius* subsp. *dacunhae* n. sp.

*Senilites tristanicola* n. gen. n. sp.

## FAM. HYDROPHILIDAE.

*Cercyon (Ercyon) litoralis* Gyll.

*C. (Paraliocercyon) depressus* Steph.

## FAM. PTILIIDAE.

*Ptinella Natvigii* n. sp.

## FAM. STAPHYLINIDAE.

*Oxytelus (Anotylus) Christophersenii* n. sp.

*Quedius mesomelinus* (Marsh.).

*Q. fulgidus* (F.).

*Atheta (Acrotona) sp. prope laticollis* (Steph.).

## FAM. CUCUJIDAE.

*Ahasverus advena* (Waltl.).

## FAM. LATHRIDIIDAE.

*Cartodere filum* (Aubé).

*Corticaria serrata* (Payk.).

## FAM. OEDEMERIDAE.

*Nacerda melanura* (L.).

## FAM. CURCULIONIDAE.

Subfam. *Rhyncophorinae*.

*Sitophilus oryzae* (L.).

Subfam. *Cossoninae*.

*Stenoscelis hylastoides* Woll.  
*Pentarthrum Carmichaeli* Waterh.  
*P. tristanensis* n. sp.  
 Subfam. *Erirrhinae*.  
*Palaechtus glabratus* Waterh.  
*Palaechtodes cossonoides* (Waterh.).  
*Inaccodes oblongus* n. gen. n. sp.  
*Gunodes major* n. gen. n. sp.  
*Tristanodes integer* n. gen. n. sp.  
*T. conicus* n. sp.  
*T. Sivertseni* n. sp.  
*T. attai* n. sp.  
*T. medius* n. sp.  
*T. minor* n. sp.  
*T. Reppetonis* n. sp.  
*T. echinatus* n. sp.  
*T. insolidus* n. sp.  
*T. scirpophilus* n. sp.  
*T. craterophilus* n. sp.

The material thus proved to be fairly heterogeneous. Several species are apparently imported. This refers to the following synanthropic species, only recorded from the island Tristan with a permanent human population: *Ahasverus advena*, *Cartodere filum*, *Corticaria serrata*, and *Sitophilus oryzae*. The other species divide into two groups: those which to a larger or lesser extent are dependent of man for their occurrence on the islands, and those which are doubtlessly autochtone. The species of the first category are 9. Most of them are widely distributed, and have a northern (holarctic) origin: *Quedius mesomelinus*, *Q. fulgidus*, *Cercyon litoralis*, *C. depressus*, and *Nacerda melanura*. One species originates from South America, viz. *Lancetes varius*, and two from South Africa, viz. *Oxytelus Christophersenii* and *Stenoscelis hylastoides*. Several of these species have adjusted themselves very well in the natural conditions, where they live quite independent of human culture. This is true of *Quedius mesomelinus* which has been collected in large numbers on several biotopes from the shore region to the crater lake on the summit of Tristan (altitude 1930 m.), and also for *Lancetes varius* which has been caught in different waters. This wide spreading just as the fact that the number of immigrants acclimatized is very large in relation to the number of species living on the islands, must be caused by the fauna vacuum (involving small competition) which is present on this and most oceanic islands. The biotopes are only slightly exploited and therefore a colonization is more easily effected than in a rich fauna district.

Certainly the most interesting group is that formed by the autochtone species. It is peculiar that out of the 20 endemites in all 18 are phytophagous, but only two carnivorous. The latter are the Dytiscids *Bidessonotus involucer*, and *Senilites tristanicola*. Thus the chief component of the original fauna is formed by the Phytophaga. Of these 15 are herbivorous, e.g. they exist as far as known on living cormophytes and mosses. They are all weevils belonging to the subfamily Erirrhinae. Two species are xylophagous (*Pentarthrum Carmichaeli* and *P. tristanensis*), while one is mycetophagous (*Ptinella Natvigii*). A grouping of the autochtone fauna like this, is not, however, unique for Tristan da Cunha. On the contrary, the phytophagous beetles play a very

important rôle on all the Antarctic, Subantarctic and South Temperate groups of islands. On a comparison between the beetle fauna of the southern island groups and that of the Arctic islands, we find, that the first mentioned is an old specific and chiefly phytophagous rest fauna, while the latter is a young carnivorous invasion fauna, originating from the northern continents.

What is then the origin of the autochtone species of the Tristan beetle fauna? From a biogeographical point of view it would be plausible to assume that a preglacial land-bridge had existed between most islands and a continent. However, the geologist of the Norwegian expedition, Dunne, claims that probably no bridges, including Tristan da Cunha, have ever existed. Therefore we must suppose that the fauna has come by some vector from one or several fauna districts; an active spreading by flight seems improbable. A transport by birds is highly theoretical, a transport by water imaginable, a transport by wind probable. The transport by birds cannot be demonstrated on the present material. A transport by water, and esp. ocean currents has been accepted by earlier authors, as Wallace. Holdhaus (1929) and Frey (1936), however, deny the possibility of insect transport by means of ocean currents over long routes. No doubt it is possible in such cases only when the animals are sheltered in driftwood, for instance. Thus it is possible for two of the xylophagous weevils living in driftwood on the Tristan shores, viz. the *Pentarthrum* spp. But most of the weevils? Several authors, as Hesse, Allee and Smidt (1937) think that the variety of Curculionids on i.a. the Subantarctic islands could be accounted for by the transport of larvae in driftwood. This must be doubted. As a matter of fact, all weevils on Heard I., the Kerguelen, Crozet Is., the Falkland Is. and all but two on Tristan da Cunha are herbivorous, and thus the larvae do not at all live in driftwood. Further, the fact that littoral beetles of southern origin are absent on Tristan da Cunha and little prominent on other oceanic islands, indicates that water transport is relatively unimportant. Perhaps only the transport by wind remains plausible. Investigations by Coad (1931), Berland (1933), Hardy & Milne (1938), and Glick (1939) show that dispersal by wind is extensive, esp. in areas with uplands. However, the Antarctic and Subantarctic islands to-day have very little upland exposed to the prevailing west-winds. In these areas the amount of transported beetles cannot be large; especially as most beetles in this region have only rudimentary flying wings. Only two of the 20 autochtone species living on Tristan da Cunha have well-developed flying-wings, and these are the xylophagous *Pentarthrum* species, living in driftwood on the shores! As a secondary phenomenon, however, the shortwingedness has no importance at the discussion of the original convergence of the old beetle fauna of Tristan. For these reasons we must assume with Christophersen that the agencies of dispersal operating under the present conditions cannot alone account for the origin of the flora or fauna of Tristan da Cunha. The beetle population of this island group seems to be the remainder of a fauna, originating from lands where the faunae now have changed or are extinct. If we suppose that the beetles invaded the islands by means of wind and, to a little extent, water, the fauna must have originally been disharmonic owing to the difficulties of immigration. The long persistence, however, made the beetle population "secondarily more harmonic through adaptiv radiation of the earlier immigrant stocks", in the terms of Huxley (1945). This differentiation into a variety of forms is a characteristic of many old oceanic islands. The Palaechtini of Tristan da Cunha afford a remarkable example. The genus *Tristanodes* divides into 4 groups, regularly distributed on the 3 islands Tristan, Inaccessible, and Nightingale:

	Tristan	Inaccessible	Nightingale
The <i>integer</i> -group			
<i>T. integer</i> .....		+	
<i>T. Siveritseni</i> .....			+
The <i>attai</i> -group			
<i>T. attai</i> .....	+		
<i>T. medius</i> .....		+	
<i>T. minor</i> .....			+
The <i>craterophilus</i> -group			
<i>T. craterophilus</i> .....	+		
<i>T. echinatus</i> .....		+	
<i>T. insolidus</i> .....			+
The <i>Reppetonis</i> -group			
<i>T. scirpophilus</i> .....	+		
<i>T. Reppetonis</i> .....		+	
<i>T. conicus</i> .....		+	

In the *integer*-group we lack a species from Tristan, and in the *Reppetonis*-group *T. conicus* is recorded from Inaccessible and not from Nightingale, but else each of the 3 species in every group lives on its island.

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## EGGS, EGG-LAYING HABITS AND LARVAE OF SHORT-NOSED WEEVILS

By F. I. van Emden

Weevil-larvae are frequently found to do serious damage to cultivated and other plants, and their identification is therefore often of considerable importance, especially as the bionomics of the weevils, and in accordance with them the control, are by no means identical. In many groups of weevil-larvae the food-plant and the location and type of damage enable a more or less useful identification for practical purposes to be made, but in the case of the larvae of short-nosed weevils (*Adelognatha*) and some transitional groups (e.g. *Allophini*) this method is of little avail, as most genera are polyphagous both as larvae and as adults, and as almost all of them in the larval stage live in the soil as external root-feeders. For these reasons a taxonomic study of the larvae of short-nosed weevils was commenced about 15 years ago; its full results will be published elsewhere. It seems desirable, however, in the meantime to point out some differences in the eggs and egg-laying habits, observed in my breeding experiments, to describe a very simple method for obtaining eggs and first-stage larvae, to enumerate shortly the more important characters available for the classification of the larvae and to emphasize the disappointingly great discrepancies between the classification of the adults and larvae in this group.

Most of the eggs are oblong-ovate and up to almost two-and-a-quarter times longer than wide (fig. 1, a—q). Too much stress must, however, not be laid on minor differences of shape and size, as a considerable amount of variation is observed. On the other hand in *Otiorrhynchus*, *Sitona* and *Allophus* (fig. 1, r—z) the eggs are more or less spherical or shortly ovate, but in *Phyllobius calcaratus* F. (fig. 1, p) and *Scythropus mustela* Hbst. (fig. 1, f) of the group with oblong eggs the shape of the egg tends towards the *Otiorrhynchus*-group. In *Otiorrhynchus raucus* F. (fig. 1, r) the egg is in turn more oblong even than in the two species just mentioned. The two groups are thus not divided by a sharp line and do not reflect in any straightforward way the classification of the adults (table 1). The same applies to the coloration of the eggs. When freshly deposited they are always of a whitish colour, and in most forms (fig. 1, a—p, r—t) this colour changes within two days to pale yellow or orange yellow. In *Barynotus* (fig. 1, q), *Sitona* (fig. 1, w—y), *Allophus* (fig. 1, z) and some *Otiorrhynchus* (fig. 1, u—v) however, the chorion turns grey and in the end, after about two days, deep black. Nevertheless, some connection between coloration and systematic position may exist, as there is perhaps some relationship between *Sitonini* and *Allophini*, and as the adults of *Otiorrhynchus laevigatus* F. and *niger* F. are rather closely related with each other. The various eggs in fig. 1 have been drawn to the same scale, and the figure in each egg indicates the length (in mm.) of a medium-sized female. It will be seen that the size of the eggs, too, cannot be directly related to the systematic position of the species, nor is it simply an expression of the size of the adult<sup>1</sup>.

<sup>1</sup> Even if the volume of the abdomen and of the egg are compared, these two statements remain substantially true, except for the fact that *Sitona griseus* differs from the rest of the species by proportionately much larger eggs (*Trachyploeus* following next and *Scythropus* and especially *Brachyderes* excelling by especially small eggs in proportion to the volume of the female abdomen).

Table 1. Eggs and egg-laying habits.

Genus	Adult classification		E g g s						
	Subfamily	Tribe	deposited between adjoin- ing surfaces	in batches	remaining pale	oblong	subglobular	becoming black	deposited singly at random
Barynotus	Brachyderinae	Barynotini	+	+		+		+	
Polydrosus	do.	Polydrosini	+	+	+	+			
Scythropus	do.	do.	+	+	+	+			
Brachyderes	do.	Brachyderini	+	+	+	+			
Barypithes	do.	do.	+	+	+	+			
Sciaphilus	do.	do.	+	+	+	+			
Strophosomus	do.	Strophosomini	+	+	+	+			
Neliocarus	do.	do.	+	+	+	+			
Phyllobius	Otiorrhynchinae	Phyllobiini	+	+	+	+			
Trachyphloeus	do.	Trachyphloeini	+	+	+	+			
Otiorrhynchus ovatus, ligustici, raucus	do.	Otiorrhynchini	(+)	(+)	+	(+)	+		+
Otiorrhynchus niger, laevigatus	do.	do.					+	+	+
Sitona	Brachyderinae or Sitoninae	Sitonini					+	+	+
Alophus	Alophinae	Alophini					+	+	+

In the majority of the genera the eggs are deposited in batches (table 1) in cracks or between two leaves (or needles) held together during oviposition by the legs of the female and afterwards by a secretion with which the eggs are glued to the adjoining surfaces. In *Sitona*, *Alophus* and *Otiorrhynchus* on the other hand the eggs are dropped at random, so that they are deposited singly and without cover. Although the species of a genus and the genera of a tribe as a whole use one-and-the-same type of oviposition, there is again no dividing line recognisable which would separate e.g. the Brachyderinae from the Otiorrhynchinae. On the contrary in *Barynotus* a considerable proportion of the eggs is deposited openly in loose lumps, and *Otiorrhynchus raucus* F. and especially *ovatus* L. use freely the folded blotting paper for laying their eggs, the behaviour of these forms thus being transitional.

For obtaining the eggs I kept the adults in petri dishes on damp blotting paper and fed them on a variety of young leaves, those leaves being offered more plentifully, which had been eaten well on the preceding few days. Except for *Sitona* and *Scythropus*<sup>2</sup> all the species reared by me proved to be more or less polyphagous. Each petri dish contained in addition to the food a pad of blotting paper, tied up in zig-zag folds and cut to lengths of about 1 cm. (fig. 2). The only difficulty with this method was

<sup>2</sup> and possibly *Trachyphloeus*.

Table 2. Classification of larvae and adults.

Genus	Adult classification		Larval characters				
	Subfamily	Tribe	number of setae on alar area	anterior epipharyngeal setae longer than posterior ones	seta 2 of pedal lobes	sclerotization of hind end	abdominal spiracles of older larva
Pantomorus	Brachyderinae	Naupactini	2	+	+	—	ovate-fringed
Ophryastes (?)	(Leptopinae)	(Ophryastini)	2	+	+	—	ovate-fringed
Mesagroicus	Brachyderinae	Naupactini	1	—	+	B	annular
Trigonoscuta	do.	Barynotini	2	—	+	B	annular
Barynotus	do.	do.	2	—	+	—	annular
Epicaerus	do.	do.	2	—	+	—	bicameral
Psalidium	do.	Psalidiini	1	—	+	—	annular
Polydrosus	do.	Polydrosini	1	+	—	—	pseudannular
Scythropus	do.	do.	1	+	—	—	?
Brachyderes	do.	Brachyderini	1	+	—	B	annular
Barypithes	do.	do.	1	+	—	—	pseudannular
Sciaphilus	do.	do.	1	+	(—)	—	pseudannular
Strophosomus	do.	Strophosomini	1	+	(—)	B	?
Neliocarus	do.	do.	1	+	(—)	B	annular
Philopeton	do.	Cneorrhinini	2	+	+	A	annular
Tanymecus	do.	Tanymecini	2	—	+	B	annular
Pachneus	do.	do.	2	(—)	+	—	bicameral
Chlorophanus?	do.	do.	2	—	+	A	annular
Piazomias	do.	Piazomiini	1	—	(+)	A	?
Leptomias	do.	do.	1	—	+	A	pseudannular
Pachynotus	do.	do.	1	—	+	A	bicameral
Maleuterpes	do.	Ottistirini	2	—	—	—(x)	bicameral
Sitona	Brachyderinae or Sitoninae	Sitonini	1	(—)	—	—	bicameral
Brachycerus	Brachycerinae	Brachycerini	2	—	+	—	ovate-fringed
Alophus	Alophinae	Alophini	1	—	—	—	?
Trichalophus	do.	do.	1	—	—	—	annular
Triglyphulus	do.	do.	1	—	—	—	annular
Lepidophorus	do.	do.	2	+	—	—	bicameral
Dyslobus	Leptopinae	Leptopini	2	—	(+)	—	annular
Prepodes	do.	do.	2	—	+	—	ovate-fringed
Panscopus	do.	do.	2	—	—	A	annular
Premnotrypes	do.	do.?	1	—	—	—	bicameral
Trypopermnon	do.	do.?	1	—	—	—	bicameral
Entimus	do.	Entimini	2	—	(—)	—	annular
Eudiagogus	do.	Promecopini	?	—	—	—	?
Agasphaerops	Otiorrhynchinae	Otiorrhynchini?	2	—	+	A	bicameral
Hormorus	do.	do.	2	—	+	A	bicameral
Rhyncogonus	do.	nr. Celeuthetini	2	—	+	A	ovate-fringed
Agraphus?	do.	do.	2+	+	+	A	annular

\* with a subterminal disc surrounded by setae.

Genus	Adult classification		Larval characters				
	Subfamily	Tribe	number of setae on alar area	anterior epipleurite spiracles larger than posterior ones	seta 2 of pedal lobes	sclerotization of hind end	abdominal spiracles of older larva
Otiorrhynchus	do.	Otiorrhynchini	1	+	—	—	pseudannular
Phyllobius	do.	(Phyllobiini)	1	+	—	—	annular
Trachyploeus	do.	Trachyploeini	1	+	—	A	annular
Peritelinus	do.	Peritelini	1	+	—	A	bicameral
Nemocestes	do.	do.	1	+	—	A	annular
Ectemnorrhinus	do. (?)	Ectemnorrhinini	1	(—)	—	—	bicameral
Cyrtepistomus	Eremninae	Cyphicerini	1	+	+	C	annular
Calomycterus	do.	do.	1	+	+	C	annular
Thlipsomerus	do.	do.	1	+	+	C	annular
Amblyrrhinus	do.	do.	1	+	+	C	pseudannular
Pseudoneorhinus	do.	do.	1	+	(+)	A	?

a somewhat unexpected one: the legless larvae, whose first task it is to reach the soil, to burrow into it and to seek out actively suitable roots, are very proficient at walking, climbing glasswalls and gnawing their way through cork-stoppers. The date must therefore be noted on each blotting-pad when it is placed in the petri dish. When sufficient eggs have been laid on it, or when the first eggs are soon due to hatch (after 10—20 days at room-temperature), the pad must be replaced by a fresh one and removed to another petri dish laid out with dampened blotting paper. Here the pads, egg-masses or heaps of collected loose eggs are arranged according to the date. From this dish each batch of eggs is removed to a corkstoppered tube just before hatching is due. In the case of numerous loose eggs (e.g. in *Sitona*) it may be found that the only practicable way for dealing with larger numbers, whilst avoiding the

1. Eggs of *Adelognatha* drawn to the same scale. (Leitz eyepiece O, objective 2, camera lucida, scale 1 mm.) Eggs turning black are stippled. The figure inside each egg indicates the length of medium-sized females. — a. *Strophosomus melanogrammus* Forst., b. *S. capitatus* ab. *obesus* Marsh., c. *Brachyderes incanus* L., d. *Trachyploeus scabriculus* L., e. *Sciaphilus asperatus* Bousd., f. *Scythropus mustela* Hbst., g. *Barypterus pellucidus* Boh., h. *Polydrosus cervinus* L., i. *P. mollis* Stroem, j. *P. tereticollis* Deg., k. *Phyllobius argentatus* L., l. *Ph. oblongus* L., m. *Ph. maculicornis* Germ., n. *Ph. piri* L., o. *Ph. viridicollis* F., p. *Ph. calcearatus* F., q. *Barynotus obscurus* F., r. *Otiorrhynchus raucus* F., s. *O. ovatus* L., t. *O. ligustici* L., u. *O. laevigatus* F., v. *O. niger* F., w. *Sitona griseus* F., x. *S. regensteniensis* Hbst., v. *S. tibialis* Hbst., z. *Alophus triguttatus* F.

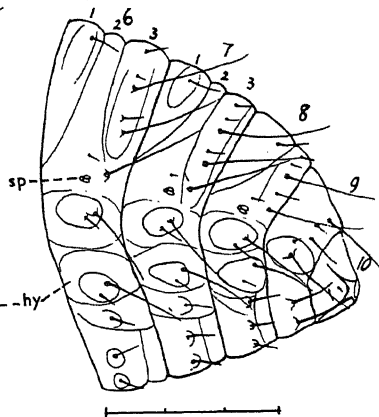
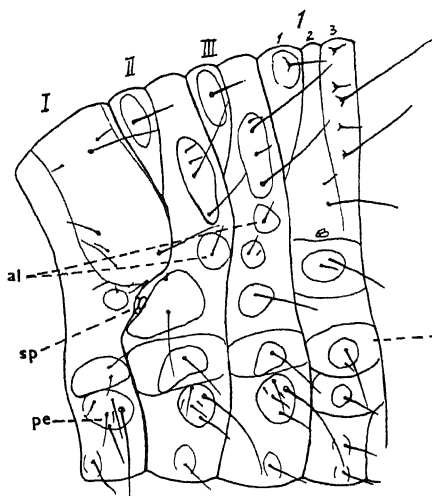
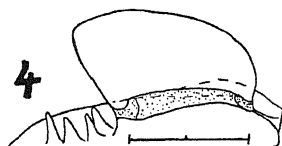
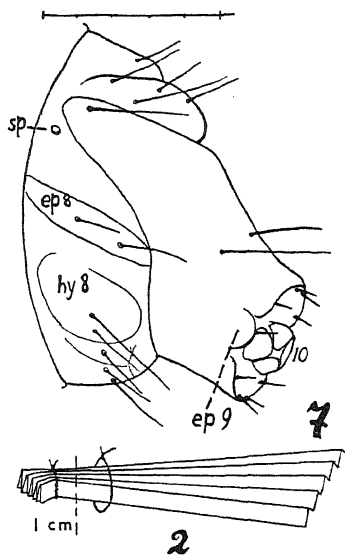
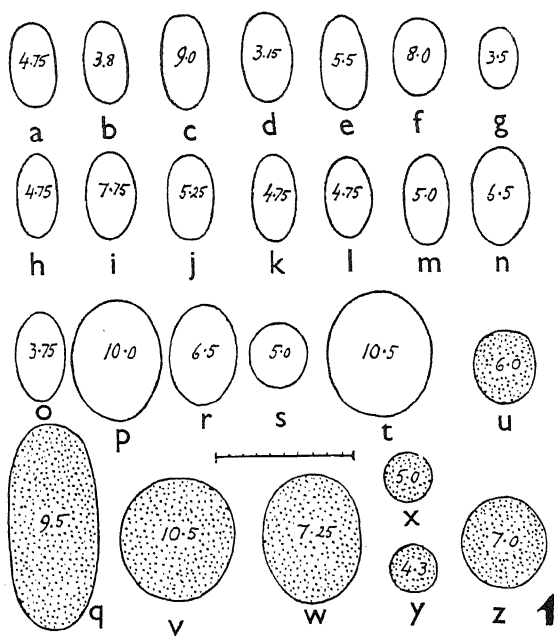
2. Folding and tying of blotting paper for producing oviposition-pads. (One-half natural size.)

3. *Otiorrhynchus ligustici* L., body of first-stage larva, lateral view. (Leitz eye-piece 4, objective 3; scale 0.3 mm.) *al*, alar area of meso- (II) and metathorax (III) with alar setae. *hy*, hypopleurite. *pe*, pedal lobe. *sp*, spiracle. 1, 6, 7 etc., abdominal segments. 1, 2, 3, dorsal folds of abdominal segments.

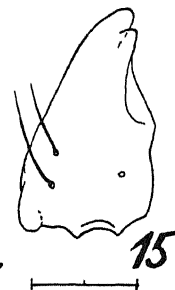
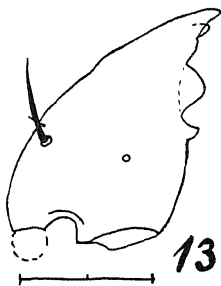
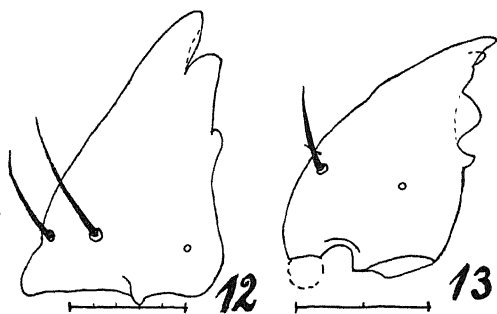
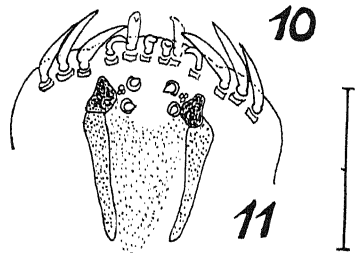
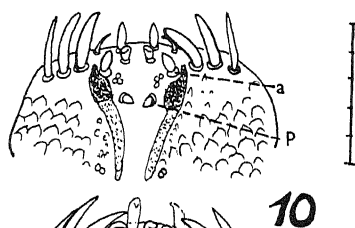
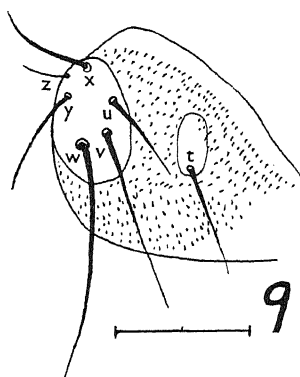
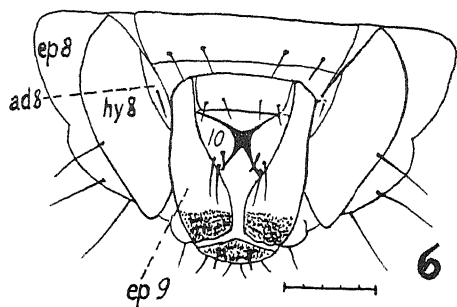
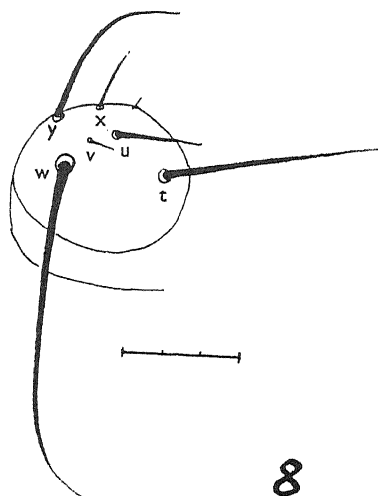
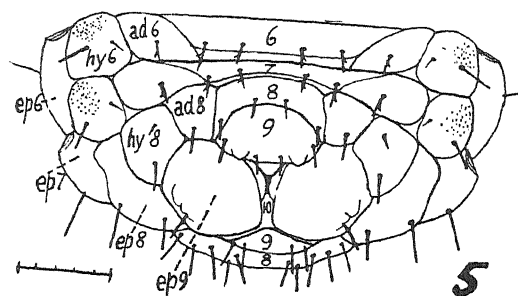
4. *Sitona griseus* F., left antenna of first-stage larva. (Leitz eye-piece 4, oil-immersion 1/12; scale 0.02 mm.)

7. *Calomycterus setarius* Roel., eighth to tenth abdominal segments of larva, lateral view. (Winkel eye-piece 4, Leitz objective 2; scale 0.5 mm.) *ep*, epipleurite. *hy*, hypopleurite. *sp*, spiracle. Example of sclerotization type C.





3



loss and mixing of hatching larvae, is to stand the petri dish in several successively larger open petri dishes (the lids always functioning as other open dishes), to keep them away from other hatching eggs, and to collect the hatched larvae at least twice a day.

The larvae of the Adeognatha are distinguished from other weevil larvae by three complete tergal folds on the intermediate abdominal segments (fig. 3) and an antenna (more correctly main sensory appendage of the antenna) which is distinctly wider than long (fig. 4), semiglobular or, if ogival, with the apex lying laterad of its longitudinal axis, provided with a more or less invaginated ring or collar-shaped basal reinforcement, and pointing forward (in morphological, i.e. ventrad in physiological, sense). Other important characters: labial palpi always two-segmented; abdominal hypopleurites (fig. 3 hy) not subdivided; antennal segments lost and only the main sensory appendage and some smaller sense organs left (fig. 4).

The outstanding result of a study of this group of weevil-larvae is an unusual uniformity in its characters, almost the only relief in which is furnished by the sclerotization of the last segments in some genera and groups of genera. These sclerotizations (figs. 5—7) are very distinctive, but though sometimes defining groups of genera and probably tribes they can obviously not be used as a primary character for a sound classification. The spiracles (fig. 3 sp) are apparently always bicameral on the thorax of the first instar and bicameral or unicameral on the abdominal segments of this instar. In older larvae, however, their structure is more varied (table 2) but again without supplying a major principle of classification. The chaetotaxy (figs. 3, 5—7) is extremely uniform but can be used for the distinction of species, genera and often groups of genera. There is no room here for a detailed account, but the chaetotaxy of the pedal lobe (fig. 3 pe) of *Polydrosus mollis* Stroem and *tereticollis* Deg. and

5. *Philopodon plagiatus* Schall., sixth to tenth abdominal segments of larva, ventro-caudal view. (Leitz eye-piece 1, objective 2; scale 0.5 mm.) *ad*, adventrite. *ep*, epipleurite. *hy*, hypopleurite. Example of sclerotization type A.

6. *Tanymecus confusus* Say 'or very near', eighth to tenth abdominal segments of larva, ventral view. (Leitz eyepiece 1, objective 2; scale 0.5 mm.) *ad*, adventrite. *ep*, epipleurite. *hy*, hypopleurite. Example of sclerotization type B.

8. *Otiorrhynchus sulcatus* F., larva, right pedal lobe of metathorax. (Leitz eye-piece 2, objective 3; scale 0.3 mm.) Note small seta *v* and absence of seta *z* (between *x* and *y*).

9. *Philopodon plagiatus* Schall., larva, right pedal lobe of mesothorax. (Leitz eye-piece 4, objective 3; scale 0.2 mm.) Note normal-sized seta *v*, presence of seta *z*, and position of seta *t* on a separate sclerite.

10. *Otiorrhynchus niger* F., epipharynx of first-stage larva, (Leitz eye-piece 2, objective 8; scale 0.05 mm.) *a*, anterior epipharyngeal spine. *p*, posterior epipharyngeal spine. The anterior spines more widely separated than the posterior ones.

11. *Psolidium maxillosum* F., epipharynx of larva. (Leitz eye-piece 4, objective 3; scale 0.2 mm.) The anterior epipharyngeal spines not more widely separated than the posterior ones.

12. *Sitona griseus* F., left mandible of first-stage larva, dorsal view. (Leitz eye-piece 1, objective 8; scale 0.05 mm.)

13. *Ectemnorrhinus* sp., left mandible of larva, dorsal view. (Leitz eye-piece 4, objective 3; scale 0.2 mm.) The condylus of the ventral surface marked by a dotted line.

14. *Brachycerus albidentatus* Gyll., right mandible of larva, dorsal view (inverted for the purpose of comparison). (Leitz eye-piece 2, objective 2; scale 0.5 mm.) The condylus of the ventral surface marked by a dotted line.

15. *Philopodon plagiatus* Schall., left mandible of larva, dorsal view. (Leitz eye-piece 3, objective 3; scale 0.2 mm.) The condylus of the ventral surface marked by a dotted line.

all studied species of *Otiorrhynchus* (fig. 8) as compared with that of the other genera (figs. 9 and table 2) may serve as an illustration of the use that can be made of chaetotactic characters. However, it must unfortunately again be emphasized that no possibility has so far been found for dividing the group by these characters into subfamilies similar to those in which the adults are classified. The only two chaetotactic characters which would seem to define larger natural groups are the number of setae on the alar area of meso- and metathorax (fig. 3 *al*; table 2) and the arrangement of the two pairs of epipharyngeal spines (figs. 10 and 11; table 2). Lastly the mouthparts, which offer so many useful characters in beetle larvae, especially the maxillae and the labium, join the rest of the body in uniformity, the ventral mouthparts supplying no character of major importance at all, whilst labrum and epipharynx (figs. 10 and 11) can be used, mainly thanks to their setae, to distinguish certain species and higher groups and the mandibles for separating the Sitonini (fig. 12), Brachycerini (fig. 14) and Ectemnorrhinini (fig. 13) by the dentate intermediate part rather sharply from the remaining groups, in which this part shows only a broadly obtuse angle (fig. 15).

It is the general experience that larvae and adults of insects can be classified in groups congruent or similar in the two stages, but although my research indicates these groups in the case of many tribes and other smaller aggregates of genera, it is difficult to see at present, how the subfamilies in the two main stages of these weevils can be brought into line. Perhaps it may be permitted here to mention that the authorities on adult weevils themselves are by no means satisfied with the classification of the adult Adelognatha, and that for instance the position of *Phyllobius* near *Otiorrhynchus* instead of near *Polydrosus* has often raised scepticism. However this may be, it seems that for the time being the classification of the larval Adelognatha will have to pursue its own way, and this implies that the identification of undescribed larvae will receive slender help from the classification of the adults. It will therefore be of special importance in this group to breed the larvae of as many species as possible, and it is hoped that these lines and the simple breeding method described above may help to stimulate such efforts.

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## A ZOOGEOGRAPHICAL CONSIDERATION OF THE INSECT FAUNA IN THE PACIFIC ISLANDS

By *Teiso Esaki*

Although the insect fauna of the Pacific Islands has not yet been adequately elucidated, the recent advances of our knowledge in this direction are of considerable magnitude. During the years 1936—1941 I made studies on the insect fauna of Micronesia, visiting those islands several times, and reached a conclusion somewhat different from those of the previous authors in regard to the zoogeographical relation of the islands. Since then a comparative study of the fauna of other Pacific islands has been made and now I want to publish a view concerning the zoogeographical feature of the islands.

### I. *General Aspect of the Chief Island-groups*

1. *Hawaiian Islands* — Hawaii was the best known amongst Pacific islands so far as the insect fauna is concerned. Since the annexion of the islands to the United States in 1898 the cultivation of sugarcane and pineapple made a considerable progress and this fact stimulated a great deal the entomological researches. The extensive work "Fauna Hawaiiensis," 1899—1913, compiled by D. Sharp in cooperation with A. Koebele, R. C. L. Perkins and G. W. Kirkaldy, included 3,325 species of insects, and a general treatise of the insect fauna given by Perkins was an important contribution to our knowledge. Since then the fauna was more thoroughly worked out by many entomologists resident in Hawaii, such as F. Muir, F. X. Williams, O. H. Swezey, D. T. Fullaway, and others.

The Hawaiian fauna is not rich in number of species and devoid of magnificent forms which may occur in tropical countries. The recent fauna contains a large number of introduced species. Of the 3,325 species known in 1913, only 2,740 could be regarded as native. Since then many Hemiptera and minute Hymenoptera were described, but on the other hand introduced species increased also a great deal, of which many were brought into the islands as natural enemies of various injurious insects. So the ratio of the native and introduced species may have been not much changed. Perkins considered that many endemic forms had become extinct by the introduced voracious ants and the insect fauna must have been much changed within last three centuries.

The most remarkable feature of the Hawaiian fauna is that the majority of the native forms are endemic, many of which are belonging to endemic genera. The general aspect of the insect fauna of the Hawaiian Islands was reviewed by Perkins. The coleopterous Family Proterhinidae, consisting of a single genus, *Proterhinus*, and ca 140 known species, can be regarded as an endemic family to these islands, although two species from the Marquesas and one each from the Samoan and Phoenix Islands have recently been known. Holdhaus attached great importance to this fact and he treated these islands as forming an independent zoogeographical region, the Hawaiian Region, separating them from the other Pacific islands.

Another important character of Hawaii differing from other groups, suggested by Holdhaus, is that the Hawaiian fauna is lacking in many important orders of insects,

such as Ephemeroptera, Plecoptera, Trichoptera, and Mecoptera. This fact is, however, also the case in other Pacific islands to a more or less extent. Termites are represented by many species in Hawaii, but a single species of which may be regarded as native; Phasmidae, Mantidae, Saltatorial Orthoptera, Aphididae, and Coccidae are all introduced forms.

Holdhaus included all the small islands west of Hawaii proper as far west as the Ocean Island in his Hawaiian Region. However, the islands from Nihoa to the Ocean Islands differ much from Hawaii proper in the composition of the insect fauna. According to Bryan, only 175 species of insects were so far discovered in these islands during his seven explorations; most of which are minute forms and their endemism is still questionable. The only definite endemic forms may be two species of *Proterhinus* found in Nihoa, the nearest island to Hawaii proper. In other words these north-western islands of the Hawaiian Group show little characteristics of the Hawaiian fauna and are not much different from the other N. W. Pacific islands in general feature.

2. *Marquesas Islands* — The Marquesas Islands were one of the most unexplored parts of the Pacific until recent time, so far as the insect fauna is concerned. In 1924 Miss Cheesman took part in St. George Expedition, and collected a number of insects, on which she published several papers. During the years 1929—1930 an extensive entomological survey was carried out by E. P. Mumford and A. M. Adamson and their results were published in three volumes of reports, cooperated by many taxonomic experts.

The general aspect of the insect fauna of Marquesas is typical of the high island type of the Pacific; endemic forms are mostly found in higher elevation, most of the insects are small in size, and several important orders are not represented. The insect fauna is similar to that of the Society Islands and of the Samoan Islands in general. The relation between Hawaii and Marquesas is not much close, except for Hemiptera-Homoptera. The chief groups which are lacking in Marquesas are Ephemeroptera, Plecoptera, Trichoptera, Mecoptera, Hemiptera-Cryptocera (aquatic Hemiptera), and many families of the other orders. The relation between Marquesas and other island-groups is rather complex.

3. *Society Islands* — Tahiti, the principal island of the group, has been since the earliest time visited by exploring navigators and many fragmental records of insects were found. The Coleoptera were comparatively well known, owing to the collection made by M. Vesco, amongst other orders of insects. Recent advances in the knowledge of insects in Society Islands were made chiefly by Miss Cheesman, as well as Mumford and Adamson as in the case of Marquesas.

The insect fauna of the Society Islands is much poorer in number of species as compared with that of Marquesas; there are no endemic genera. The low island groups east of Tahiti, such as Paumotu (Tuamotu) and Mangarewa Groups possess undoubtedly a much poorer fauna than Tahiti.

4. *Samoa Islands* — The Samoan fauna had been little explored, except for Lepidoptera and Orthoptera, until entomologists in Hawaii made explorations there recently. More recently, in 1924—25, P. A. Buxton and C.H. E. Hopkins made extensive collections, which were later worked out in the reports of nine volumes.

The general aspect of the insect fauna was reviewed by Buxton. No less than 1603 species of insects became known to occur in Samoa, of which 787 were regarded as endemic, i.e. 49% or nearly one half of the total were endemic. The analysis of

the insect fauna reveals that the Samoan Islands are distinctly oceanic, never had a connection with the continent or even with the nearest island group of Fiji. The high percentage of endemic forms does not always show the very old formation of the islands. The resemblance of the insect fauna between Hawaii and Samoa may not be due to the direct relation between them, but to the similarity of the conditions influencing the isolation and the distribution of insects in both the groups. Holdhaus assumed that Samoa is the eastern limit of the Melanesian Subregion, but this opinion is now proved to be incorrect. The chief orders which do not occur in Samoa are Plecoptera and Mecoptera; Trichoptera and Ephemeroptera are represented by one each endemic species. *Proterhinus* (Coleoptera) and *Austrochrysa* (Neuroptera) are found in Samoa which have previously been regarded as endemic to Hawaii. Some continental genera, such as *Simulium* (Diptera) and *Libythea* (Lepidoptera), are known to occur in Pacific islands east of Samoa, but not in Samoa.

5. *Fiji Islands* — Apparently there is no recent extensive survey of the insect fauna of Fiji, however, chief orders such as Coleoptera, Lepidoptera, Hemiptera, and Orthoptera were fairly well worked out, and the ant fauna has recently been much elucidated. Although there are a number of species which are common to both Samoa and Fiji, the general aspect of the insect fauna in Fiji is distinctly Melanesian, and there is little doubt that the Fiji Islands are continental. The number of species is much larger than that in Samoa. It may be not necessary to point out that those islands west of Fiji, such as New Hebrides, New Caledonia, the Solomon and Bismarck Groups, belong to the Melanesian Subregion.

There are many small islands east of Fiji, from which fragmental records of insects were made. All of them, including Gilbert, Ellice, Phoenix, Union and Manihiki Groups as far east as the Easter Island, are oceanic and the insect fauna is generally very poor. The Gilbert and Ellice Groups are generally included in Micronesia, the general aspect of which is very similar to that of the Marshall and Caroline Islands in the north.

6. *Marshall and Caroline Islands* — All of the Marshall Islands and the Caroline Islands, excluding Kusaie, Ponape, and the Truk Group, are atolls and the aspect of the insect fauna is typical of oceanic low islands; it contains very few species, most of which are either small, inconspicuous, very widely distributed tropicopolitan or introduced species. Yap is generally included in the Caroline Group, but zoogeographically it must be separated from the other islands of the group and is forming a natural chain with the Palau (or Pelew) Islands, which may also occasionally be included in the Carolines.

Kusaie, Ponape, and the Truk Group are of old volcanic origin and mountainous. They contain a number of endemic species as well as a few endemic genera, and must be separated from the other islands of the Caroline Group. They are, however, oceanic but not continental.

7. *Marianne Islands* — The Marianne Islands are neoeffusic, the insect fauna is more closely related to the Oriental Region than any other groups in the Pacific. Endemic genera and species are few in number. There are distinct differences from each of the Bonin, Palau, and Caroline Groups. There is no Cicadid-species occurring in the Mariannes.

8. *Bonin Islands* — The faunistic feature of the Bonin Islands is very peculiar so far as the insects are concerned. As the Marianne Islands they belong undoubtedly to the Oriental Region, but the components of the fauna appear of older origin and

contain several, if not many, endemic forms. Both the island groups, however, belong neither to the Indo-chinese Subregion as Formosa nor to the Melanesian Subregion; their situation is rather intermediate.

9. *Palau (or Pelew) Islands* — The Palau Islands, including Yap, have much the richest fauna among Micronesian islands and contain a number of interesting endemic genera and species. The Palau Islands, including Yap, must be separated from the rest of the Caroline Islands both geologically and topographically, as already pointed out by Tayama. Micronesia lacks also several important orders and families of insects. Among others the following groups may be given as not to be found in Micronesia including the Palau Islands: Plecoptera, Ephemeroptera, Mecoptera, Hymenoptera-Symphyta, Chrysidae, Cicindelidae, Gyrinidae, Simuliidae. Trichoptera are represented by one species each in Palau and Ponape. On the other hand, Mutillidae, Scoliidæ, Crabronidae, Tipulidae—Tipulinae, *Orthopodomyia* (Culicidae), Rutelidae, Dynastidae, Passalidae, Papilionidae and many genera occur only in the Palau Islands within Micronesia, if those assumed to be recently introduced species are not concerned. The richness of the fauna of the Palau Islands as compared with other groups in Micronesia reveals that the islands are undoubtedly continental, the fact also supported by the evidences of submarine topography, geology, and phyto-geography.

## II. Zoogeographical Considerations

Holdhaus showed in his map of the geographical distribution of insects that the Pacific islands belonging to the Australian Region and are subdivided into Melanesian and Polynesian Subregions, except for the Hawaiian Islands, which he treated as a distinct group, the Hawaiian Region. The Melanesian element is known to be spread into the Australian Continent and mixed with the Australian elements. The former element reaches as far south as the northern limit of New South Wales, and the transition to the latter element is gradual and can not be separated geographically. A similar fact is also recognizable in the west, where the Melanesian Subregion is transferred to the Malayian Subregion of the Oriental Region gradually. The Melanesian elements have generally been treated as belonging to the Australian Region. However, the components of the Melanesian elements are mostly of the Asiatic continental origin and only a very few of them can be considered to be of Australian origin. In fact, the insect fauna of Melanesia is very little related to the peculiar fauna of Australia and New Zealand. Thus the chief components of the Melanesian fauna should belong to the Oriental Region but not to the Australian. Therefore the Australian Region may be restricted to the greater part of the Australian Continent, New Zealand, and several islands attached to them. The Weber's Line, which passes east of Timor, Sulu, and Celebes, or its modified line of Pelsneer is of little significance as the eastern limit of the Oriental elements, so far as the insects are concerned. The northern invasion of the Australian elements is very slight as compared with that of the Vertebrates, so that the above-mentioned lines are also not at all important as the western limit of the Australian element.

Holdhaus divided the Pacific islands, except Hawaii, into the Melanesian and Polynesian Subregions. Samoa was included in the former by Holdhaus, but, as recently pointed out by Buxton, the Samoan Islands are not continental, and distinctly separated from the Fiji Islands. The number of species in Samoa is also much smaller than that of Fiji. Thus Samoa should go to the Polynesian Subregion. The Tonga Islands are



not yet well surveyed, but it is highly probable that they are also Polynesian, but not Melanesian. Both the subregions, therefore, should be separated between Fiji and Tonga.

The most noteworthy thing is the situation of the Palau Islands, including Yap. These islands contain a much richer fauna as compared with the other Micronesian and Polynesian Islands, and the analysis of the insect fauna shows that these islands should belong to the Melanesian Subregion, but not to the Polynesian. Of course, the fauna of Palau is much poorer than that of New Guinea, and the relationship between them is apparently not distinct. This fact, however, may be explained from the fact, that the Palau Islands are separated from New Guinea by a deep trench, but they are topographically connected through the Moluccas. This assumption is also supported by the evidences that the Palauan fauna shows some similarities with that of the Moluccas and the Philippines. The Melanesian Subregion, therefore, extending as far north as the Palau Islands and Yap and only so far as the Fiji in the east.

The insect fauna of the atolls and small table reefs, of which the greatest part of Micronesia is composed, is extremely poor and similar to each other and consists of minute or immigrant forms, which can be easily transported by wind and current, or those spread in companion with the human traffic, and endemic species are scarcely occurring. The fauna becomes poorer eastwards, thus the same of the Paumotu and Mangarewa Islands is much more limited than that of the Micronesian islands and perhaps the poorest in the Easter Island. The relation between the Pacific Islands and the American Continents is very scarce, except for Galapagos and several others. This fact signifies that the principal components of the Pacific insect fauna are derived from the west. As already pointed out several families and genera of the Melanesian origin are known to occur in Marquesas, but not in Samoa. The degree of endemism is not always parallel with the geographical, topographical or geological evidences among different groups of islands. These facts may be explained by the various methods of transportation of insects from west to east which depend largely on chance.

The Polynesian Subregion may be divided into two sections roughly along the 180° of longitude, to the east of which is the Polynesian Section, and to the west the Micronesian Section. The Polynesian Section consists of the Hawaii, Marquesas, Society, Samoa, and Tonga Groups as well as a number of smaller low islands. The insects of the Melanesian origin found in these islands are not mutually related but independently introduced from Melanesia. The endemism is the highest in Hawaii, then followed by Marquesas and further in the order, Phoenix—Samoa—Tonga—Tahiti.

The Micronesian Section consists of the Caroline high islands (Kusaie, Ponape, and Truk), the Marianne and Bonin Islands together with a number of low coral islands. The Caroline high islands are related to some extent to the nearest Melanesian islands, the Bismarck Archipelago and the Solomon Islands. The occurrence of a Nymphalid-butterfly, *Hypolimnas alimena* in Ponape may be a case showing the above-mentioned assumption. The Marianne Islands are related to the Palau Group (including Yap) which is now to be included in the Melanesian Subregion. The Bonin Islands show much the Oriental feature, the Melanesian elements are scarcely represented.

### III. Summary

1. The whole Pacific islands except those closely situated to Australia and New Zealand and to the American Continents, should belong to the Oriental Region instead of to the Australian Region, so far as the insects are concerned.

2. These islands belong to two subregions of the Oriental Region, i.e. the Melanesian and Polynesian Subregions.

3. The Melanesian Subregion extends as far east as Fiji, and the Samoa and Tonga Groups, which were hitherto generally included in this subregion, should be transferred to the Polynesian Subregion.

4. The Polynesian Subregion may be subdivided into two sections along the longitude  $180^{\circ}$ , the east of which is the Polynesian Section, the west the Micronesian. The former consists of Hawaii, Marquesas, Society, Phoenix, Samoa, and Tonga with many other low islands, while the latter contains the whole Micronesian islands except the Palau Group including Yap. The Bonin Islands are also included in the latter section.

5. The Palau Group, including Yap, are closely related to the Melanesian islands and much richer in faunal composition than the other Micronesian islands, and should be transferred to the Melanesian Subregion.

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A PROPOS DES *Reticulitermes* DE FRANCE

Par J. Feytaud

Le genre *Reticulitermes* fut créé en 1913 par Holmgren pour séparer des *Leucotermes* proprement dits un certain nombre d'espèces réunies précédemment avec eux, mais offrant des caractères bien spéciaux : ailes réticulées et présence d'ocelles entre autres. Il groupe les principaux Termites des régions tempérées de l'Hémisphère Nord.

Lors de sa création on connaissait déjà cinq espèces : *Reticulitermes lucifugus* Rossi (1792), *R. flavipes* Kollar (1837), *R. speratus* Kolbe (1885), *R. virginicus* Banks (1907), *R. flaviceps* Oshima (1912); *lucifugus* était de la région méditerranéenne, *speratus* et *flaviceps* du Japon, les autres des Etats-Unis d'Amérique, où Banks (1920) en distingua six nouveaux : *claripennis*, *hageni*, *hesperus*, *humilis*, *tibialis* et *tumiceps*, et Goellner un septième, *arenicola*, observé sur les dunes proches du lac Michigan, cependant que Snyder (1923) et Light (1924) décrivaient respectivement *chinensis* et *fukiensis* de Chine.

Avec trois fossiles de l'ambre de la Baltique et trois des schistes miocènes du Colorado, cela fait une vingtaine d'espèces.

Bien que *R. flavipes* ait été décrit par Kollar sur des exemplaires recueillis en Autriche, dans une serre du château de Schoenbrunn, où l'entrée de quelque plante de provenance étrangère avait fait apparaître un foyer temporaire accidentel, comme il arriva depuis pour le Lucifuge dans une serre du Jardin des Plantes de Paris, ce dernier, *R. lucifugus* Rossi, était le seul que l'on connût dans la Nature en Europe. On lui donnait pour habitat tout le pourtour de la Mer Méditerranée et c'est à lui qu'on attribuait notamment les ravages constatés à La Rochelle et Rochefort.

Or, j'ai démontré en 1923 que les *Reticulitermes* des Charentes et de la Vendée n'appartiennent point à cette espèce là, qu'ils se rattachent au *R. flavipes* nord-américain, de sorte qu'en Europe l'espèce de Kollar n'a pas fait seulement de brèves apparitions accidentelles dans des serres, comme il advint à Schoenbrunn, mais a conquis de longue date une solide tête de pont dans l'Ouest, où il se trouve largement installé sur la côte depuis Royan jusqu'à Saint-Nazaire.

Il est vrai que le caractère spécifique tiré de la distance séparant des yeux les ocelles prête à discussion; chez nous l'écart est moindre que dans le type, et à peu près tel que dans *claripennis*; mais Banks et Snyder ont reçu de l'Arkansas des *flavipes* offrant une particularité analogue.

Sous réserve d'une étude plus approfondie portant sur des lots d'insectes parfaits provenant de localités diverses, je garde la désignation spécifique de *flavipes*, en lui adjoignant le qualificatif de *santonensis* à titre de sous-espèce ou de variété.

Quant au Lucifuge, il existe de nettes divergences de comportement selon les points considérés de son aire d'habitat, qui est très vaste et qui n'est d'ailleurs pas continue. J'ai regardé vivre dans mon laboratoire des lots rapportés du Roussillon et de l'Estremadure, ainsi qu'un autre reçu des environs d'Alger. Pour les trois, le dernier surtout, j'ai eu l'impression qu'il s'agissait de races distinctes du type classique de Bordeaux et des Landes.

Au reste, un fait marquant reconnu de longue date sépare du nôtre le Lucifuge d'Italie et de Sicile. Grassi et Sandias, Silvestri, Jucci, qui l'ont beaucoup étudié, n'ayant pas trouvé de reines ni de rois, admettent qu'il se reproduit uniquement par des sexués néoténiques; le bilan négatif de leurs recherches les avait même conduits à douter de l'existence des reines décrites et figurées par Léon Dufour et Lespès.

Or, j'ai reconnu le bien-fondé des affirmations de ces vieux observateurs français; j'ai même établi que, dans le Sud-Ouest de notre pays, la fondation de colonies est l'oeuvre habituelle d'imagos apparées après l'essaimage, chacun de leurs couples étant susceptible de produire, en milieu propice tel qu'une souche de pin de la forêt gasconne, une famille populeuse, une société indépendante, dont les conjoints sont reine et roi.

L'intervention de néoténiques apparaît ici non plus comme le mode exclusif et constant de la reproduction, mais comme un phénomène secondaire consécutif à la mort du roi, de la reine, ou des deux ensemble; elle n'en joue pas moins un rôle considérable puisque, tout en assurant la pérennité des familles devenues orphelines, elle augmente leur prospérité et favorise leur expansion, en raison du grand nombre des sexués qu'elle met en jeu. Elle facilite en outre la multiplication des colonies par une sorte de sectionnement analogue au bouturage.

En prospectant certaines coupes repérées lors de l'abatage des pins, il m'est arrivé de prélever sur les souches, presque à volonté et à point nommé, les couples royaux de colonies relativement jeunes et d'un âge connu (entre trois et cinq ans).

Cet exemple, tiré de la différence des races italienne et française, souligne l'intérêt de l'étude que je me suis proposé de faire : la comparaison morphologique et biologique entre des lots, aussi nombreux et de provenances aussi diverses que possible, des soi-disant *Lucifugus* de l'Europe méridionale, de l'Asie Mineure et de l'Afrique du Nord.

Pour mener à bien cette étude, je fais appel à mes collègues entomologistes des pays méditerranéens. Je les invite à m'adresser des *Reticulitermes* en bon état de conservation, imagos essaimantes et soldats en particulier, avec mention précise des lieux de prélèvement, et à me fournir les renseignements qu'ils possèdent déjà sur la façon dont ces Termites se comportent chez eux. J'entrerais volontiers en rapport avec les correspondants qui voudront bien répondre à ce désir.

Je pense qu'une telle étude comparative est susceptible d'amener la séparation de plusieurs espèces ou sous-espèces actuellement confondues sous le nom de *Reticulitermes lucifugus* Rossi.

Je rappelle que la même appellation spécifique fut attribuée naguère à des *Reticulitermes* de l'Amérique du Nord considérés comme importés d'Europe; ceux de Californie étudiés par Heath (1903) furent en 1920 distingués par Banks sous le nouveau nom d'*hesperus*; ceux des environs de Boston, observés par Dobson (1918) et retenus depuis comme de vrais *lucifugus*, ne figurent plus comme tels dans l'édition récente du livre de Snyder (1947).

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## PRÄ- UND INTERGLAZIALE RELIKTE IN DER BODENFAUNA DER NORDOSTALPEN

Von *H. Franz*

Die tiergeographischen Verhältnisse der Alpen sind in mehrfacher Hinsicht denjenigen Nordeuropas ähnlich. Das rührt daher, dass beide Gebiete in gleicher Weise während des Pleistozäns mehrere durch warme Interglazialzeiten unterbrochene Vereisungsperioden mitgemacht haben. Die Folgen der eiszeitlichen Grossvergletscherungen waren da wie dort weitgehende Zerstörung der präglazialen Flora und Fauna durch die Eisbedeckung sowie restloses Aussterben aller thermophilen und Ansiedlung kälteliebender Organismen im periglazialen Gebiet. Das Ausmass der Devastierung der alpinen Flora durch die eiszeitliche Vergletscherung der Alpen ist erstmalig von den Botanikern Chodat und Pampanini erkannt worden. Schon sie wiesen nach, dass die Armut der inneren Gebirgsgruppen der Alpen an englokal verbreiteten Endemiten eine Folgeerscheinung der intensiven eiszeitlichen Vergletscherung der betreffenden Gebirgsteile ist und stellten dem eiszeitlich devastierten Inneren die endemitenreichen eiszeitlich nicht oder nur schwach vergletscherten Randgipfel als „Massifs de refuge“ gegenüber. Die faunistischen Verhältnisse dieser randlichen Refugialgebiete der Alpen wurden vor allem von Holdhaus eingehend studiert und auch in einem Vortrage am V. Internationalen Kongress für Entomologie in Paris erörtert<sup>1</sup>. Holdhaus hat mit Unterstützung mehrerer Mitarbeiter durch planmässige jahrelange Sammeltätigkeit die Verbreitung der präglazialen Relikte in der hochalpinen Käferfauna der Ostalpen weitgehend geklärt. Er wies nach, dass die in hochalpine Lagen emporragenden Gipfel am Süd-, Ost- und zum Teile auch noch am Nordostrande der Alpen eine endemitenreiche hochalpine Käferfauna aufweisen und dass von da aus gegen das Alpeninnere eine an manchen Stellen sehr rasche, an anderen eine allmählichere Abnahme des Formenreichtums der Fauna eintritt. Für die Gebirgsfauna tieferer Lagen der Alpen stehen gleich umfassende Untersuchungen bisher aus. Nur die Verbreitung subterranean und höhlenwohnender Blindtiere hat gleichfalls durch Holdhaus<sup>2</sup> eine sorgfältige Bearbeitung erfahren.

Die Nordgrenze englokal verbreiteter subterranean und höhlenbewohnender Blindkäfer bildet im östlichsten Abschnitt der Alpen im grossen Ganzen die Talfurche der Drau. Nördlich der Draulinie sind nur ganz vereinzelte Relikte einer endemischen subterranean beziehungsweise höhlenbewohnenden Blindtierfauna aufgefunden worden. Mit Ausnahme einzelner in grossen Höhlensystemen weithin isolierter Relikte handelt es sich dabei um Vorkommnisse, die nur wenig nördlich der Draulinie gelegen sind. Da überdies aus den tieferen Lagen der südlichen Randgebiete der Alpen eine bedeutend artenreichere, viele lokale Endemiten aufweisende Waldbodenfauna bekannt ist als aus weiter nördlich gelegenen Gebirgsteilen, hat sich die Meinung herausgebildet, dass die präglaziale Waldbodenfauna während des Pleistozäns nicht nur im Alpeninneren, sondern auch am Ost- und Nordrande des Gebirges vollkommen zu Grunde gegangen sei. Für diese Annahme schien auch der Umstand zu sprechen, dass nach paläobotani-

<sup>1</sup> Holdhaus, K., Das Phänomen der Massifs de refuge in der Coleopterenfauna der Alpen. Ve Congrès international d'Entomologie, Paris 1932, p. 397—406.

<sup>2</sup> Holdhaus, K., Die europäische Höhlenfauna in ihren Beziehungen zur Eiszeit. Zoogeographica 1, 1932, p. 1—53 u. Taf. 1.

schen Befunden das Gebiet zwischen dem nordischen Eisschild und der alpinen Gletschermasse während der jungpleistozänen Vereisungsmaxima völlig waldfrei war.

Umfangreiche Aufsammlungen der Bodenfauna, die ich im Rahmen bodenbiologischer Studien und als Vorarbeit für eine tiergeographisch-bioökologische Monographie eines Teilgebietes der Nordostalpen seit Jahren durchführe, haben jedoch zu dem Ergebnis geführt, dass die devastierende Wirkung der eiszeitlichen Grossvergletscherungen im nordöstlichsten Teile der Alpen nicht so vollständig gewesen ist, wie man bisher meinte.

Ich möchte Ihnen, bevor ich auf Einzelheiten meiner Befunde eingehe, eine Karte des östlichsten Teiles der Alpen zeigen, worauf die maximale eiszeitliche Vergletscherung dieses Gebietes angegeben ist. In Karte 1 ist das während des ganzen Pleistozäns unvergletscherte Gebirge unterhalb der tiefsten eiszeitlichen Schneegrenzlage schraffiert dargestellt. Das von den grossen Alpengletschern bedeckte Gebiet blieb weiss und ist dort, wo die Gletscherströme sich ins Vorland ergossen, gegenüber den gleichfalls weiss belassenen Aufschüttungsebenen durch eine schwarze Linie abgegrenzt. Das über der orographischen Schneegrenze gelegene, grösstenteils verfirnte, aber nicht von Gletschern bedeckte Hochgebirge ist durch schwarze Farbe hervorgehoben.

Hier gab es wie heute auf den höchsten Erhebungen der Alpen da und dort Stellen, die infolge ihrer Steilheit dem Schnee keinen Halt boten oder infolge ihrer Windausgesetztheit immer wieder kahlgefeigt wurden. An solchen Plätzen vermochten auch während der Eiszeiten einzelne besonders wetterharte Organismenarten zu leben. Man

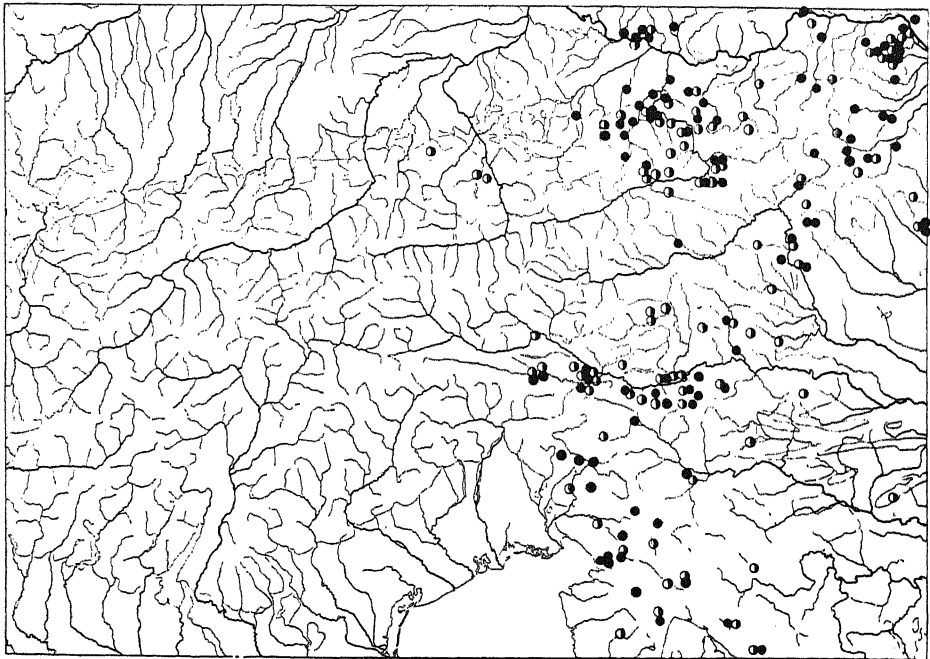


Karte 1: Eiszeitkarte des östlichsten Teiles der Alpen. (Erläuterungen im Text.)

nennt solche Felsinseln mitten in der Eiswüste mit einem Ausdruck der Eskimosprache Nunatakr, die auf ihnen erhalten gebliebenen Relikte Nunatakrelikte. Wo eiszeitliche Gletscher die Täler bis zur Schneegrenze, die im Durchschnitt auf 1300 bis 1700 m herabgedrückt war, erfüllten, stand nur dieser kärgliche Lebensraum für Nunatakbewohner zur Verfügung.

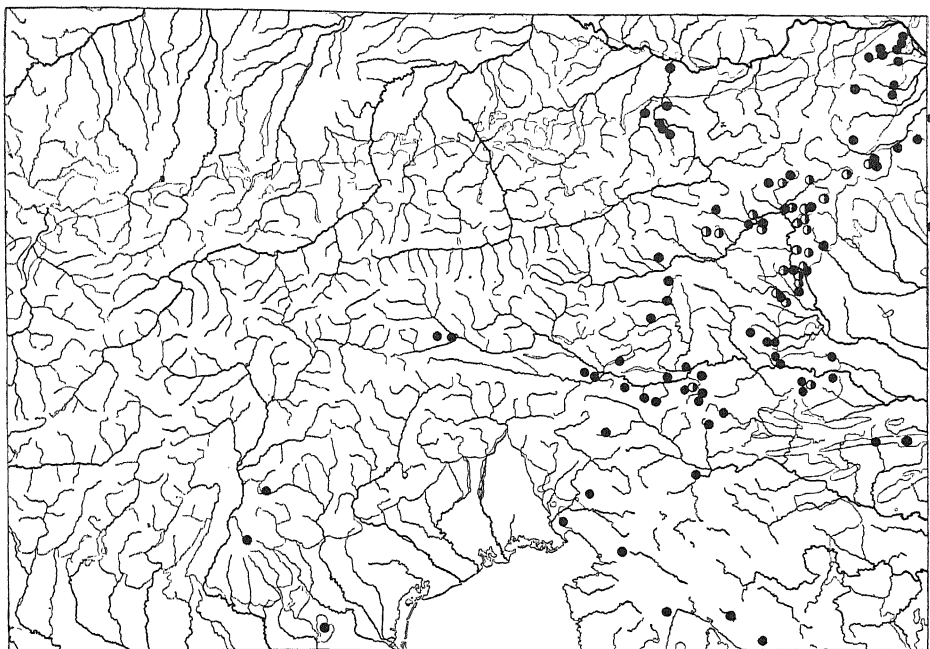
Wo sich das Niveau der Talgletscher aber tiefer absenkte, aperte im Sommer ein mehr oder weniger breiter Hangstreifen aus, der mit alpiner Polsterpflanzen- und Schneetälchenvegetation, ja an günstigen Stellen selbst mit alpinen Grasheiden bewachsen war. An solchen Örtlichkeiten konnten auch anspruchsvollere Vertreter der hochalpinen Fauna der Eiszeit trotzen. Die Möglichkeiten hierzu waren während der Würmeiszeit, in der die Gletscherströme auch in den Ostalpen fast ausnahmslos nur eine geringere Mächtigkeit und Ausdehnung erreichten als in der Risseiszeit, grösser als in dieser. Es konnten daher an verschiedenen Stellen Organismen das Maximum der Würmvereisung überdauern, wo während der Risseiszeit Gletscher alles Leben vernichtet hatten.

Völlig verschieden von den Lebensbedingungen im Bereiche der grossen alpinen Gletscherströme müssen während der Vereisungsmaxima die Bedingungen im unvergletscherten Gebiet gewesen sein. Dort stand von der in 1300 bis 1700 m Höhe verlaufenden Schneegrenze bis zum Talboden herab, das ist in den grossen Tälern in einem Bereiche von mehr als 1000 m Höhenunterschied, ein breiter Raum für die Entfaltung des Organismenlebens zur Verfügung. In diesem Raume haben sich zweifellos während des gesamten Pleistozäns wesentlich anspruchsvollere Pflanzen und Tiere



Karte 2: Verbreitung von *Aptinus bombardia* Illig. (○) und von *Platynus scrobiculatus* F. (●) in den Ostalpen.



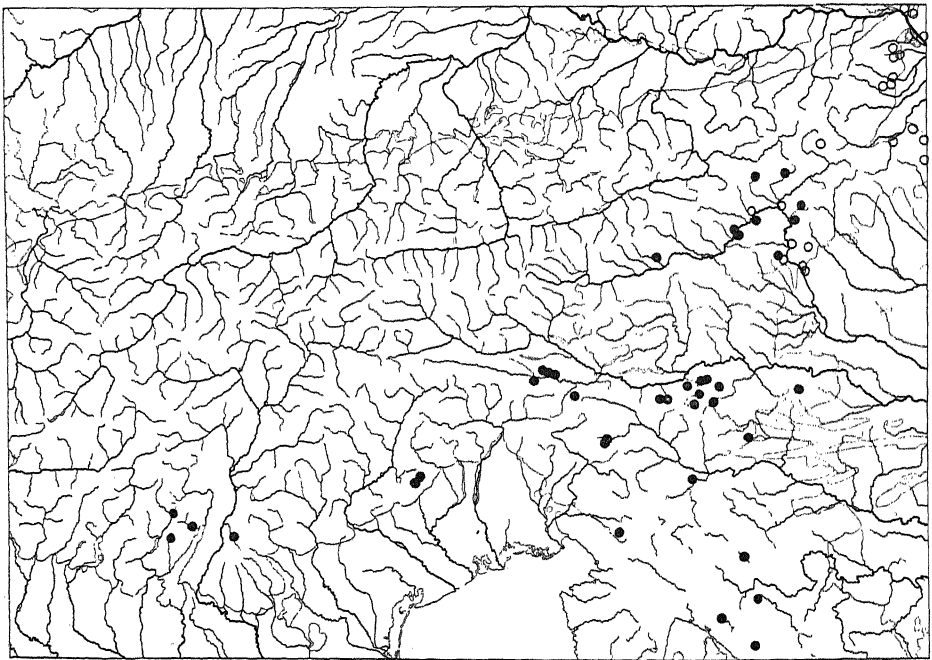


Karte 3: Verbreitung von *Laena viennensis* Sturm. (●) und von *Sipalia flava* Kr. (⊙) in den Ostalpen. Die beiden Fundorte, die für die letztgenannte Art im Gebiete der Niederen Tauern angegeben sind, beziehen sich, wie inzwischen festgestellt wurde, auf eine andere noch unbeschriebene Spezies.

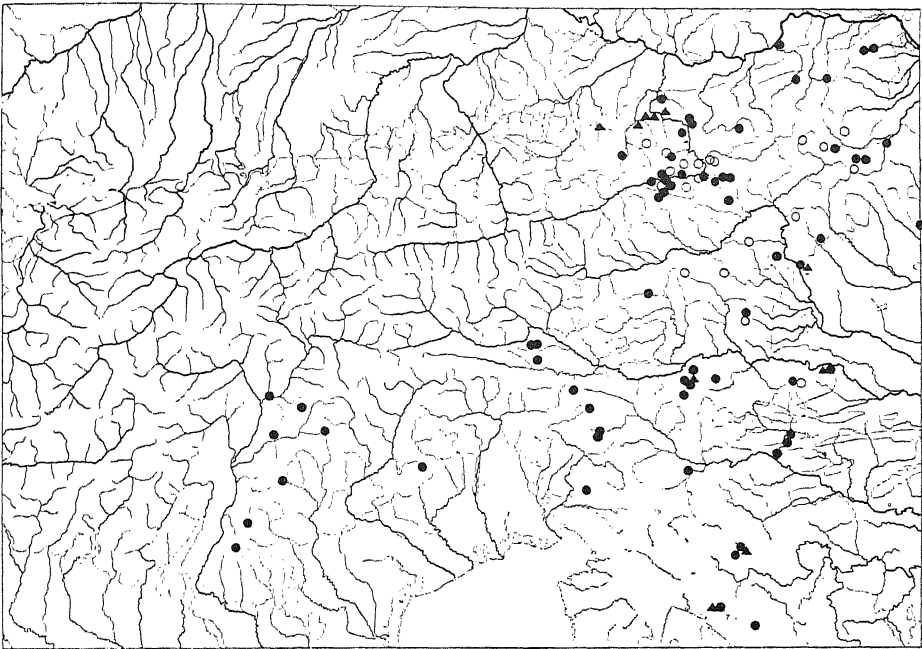
zu erhalten vermocht als im unmittelbaren Bereiche der Talvergletscherung. Die Eiszeitkarte zeigt, dass in den östlichsten Alpen ausgedehnte Gebiete dauernd unvergletschert geblieben sind. Die eiszeitliche Talvergletscherung hat im Ennstal während der Risseiszeit bei Grossraming, während der Würmeiszeit am Eingang des Gesäuses und auf der Höhe des Buchauer Sattels bei Admont geendet. Der Murgletscher lagerte seine Endmoränen während beider Eiszeiten in der Umgebung von Judenburg ab; der Draugletscher stiess bis östlich von Völkermarkt im Klagenfurter Becken vor. Karte 1 ist, dies sei bei dieser Gelegenheit erwähnt, auf Grund der glazialgeologischen Alpenliteratur entworfen worden, die für einzelne Details leider noch keine völlig gesicherten Unterlagen liefert. Dies gilt ganz besonders für die eiszeitliche Vergletscherung in einzelnen Teilen von Kärnten, wo es den Anschein hat, dass diese wesentlich weniger ausgedehnt war, als es die bisherige Literatur und damit auch die Karte angibt. In den Nordostalpen entspricht die Darstellung den tatsächlichen Vereisungsverhältnissen aber so weitgehend, dass sie eine ausgezeichnete Unterlage für biogeographische Studien bietet.

Einen Beweis hierfür liefert Karte 2, auf der die Verbreitung zweier Laufkäfer und zwar die von *Aptinus bombardae* Illig. durch ganz schwarz ausgefüllte Kreise und die von *Platynus scrobiculatus* F. durch nur zur Hälfte schwarz ausgefüllte Kreise angegeben ist. Der Vergleich der Verbreitungsbilder beider Arten mit den Grenzen des in der Eiszeitkarte verzeichneten dauernd unvergletscherten Areals zeigt für das Gebiet

der Nordostalpen eine ganz überraschende Deckung. Eine ebenso weitgehende Bindung an das dauernd unvergletscherte Gebirge zeigt die Verbreitung von *Laena viennensis* Sturm (vgl. die schwarzen Kreise auf Karte 3), während *Sipalia flava* Kr. (vgl. die nur halb schwarz ausgefüllten Kreise derselben Karte) ein wesentlich kleineres Areal bewohnt. Die auf Karte 4 durch schwarz ausgefüllte Kreise markierte Verbreitung von *Bythinus longulus* Kiesw. ist auf Teile des ost- und südostalpinen Randgebietes beschränkt, die in weiterer Entfernung von den Grenzen der eiszeitlichen Vergletscherung gelegen waren. Auch die Verbreitung von *Cephennium carpathicum* Saulcy, die in Karte 4 mit leeren Kreisen dargestellt ist, beschränkt sich deutlich auf jene nordöstlichsten Teile der Alpen, die dem Einfluss der eiszeitlichen Vergletscherung weit entdrückt waren. Ebenso ist die Verbreitung der drei in Karte 5 verzeichneten Käferarten *Pedilophorus auratus* Duftsch. (schwarz ausgefüllte Kreise), *Liosoma cyanopterum* Redtb. (leere Kreise) und *Otiorrhynchus duinensis stenorostris* Apfb. (schwarz ausgefüllte Dreiecke) auf das eiszeitlich unvergletscherte Randgebiet der Alpen beschränkt. Dabei zeigt *Pedilophorus auratus* als die Art mit den geringsten Klimaansprüchen die weiteste Verbreitung, während *Otiorrhynchus duinensis stenorostris* allem Anscheine nach nur ein beschränktes, in mehrere Reliktareale aufgelöstes Verbreitungsgebiet in den Ostalpen innehat. In Karte 6 ist die Verbreitung zweier Blattkäfer und zwar von *Sclerophaedon carniolicus* Germ. (leere Kreise) und *Chrysomela lichenis abena* Germ. (schwarz ausgefüllte Kreise) dargestellt. Die erstgenannte der beiden Arten lebt sub- und hochalpin, die zweite ausschliesslich hochalpin. Die Anpassung an das hochalpine Klima ermöglichte es beiden Arten während der Zeiten maximaler Gletscherausbreitung



Karte 4: Verbreitung von *Bythinus longulus* Kiesw. (●) und von *Cephennium carpathicum* Saulcy (○) in den Ostalpen.

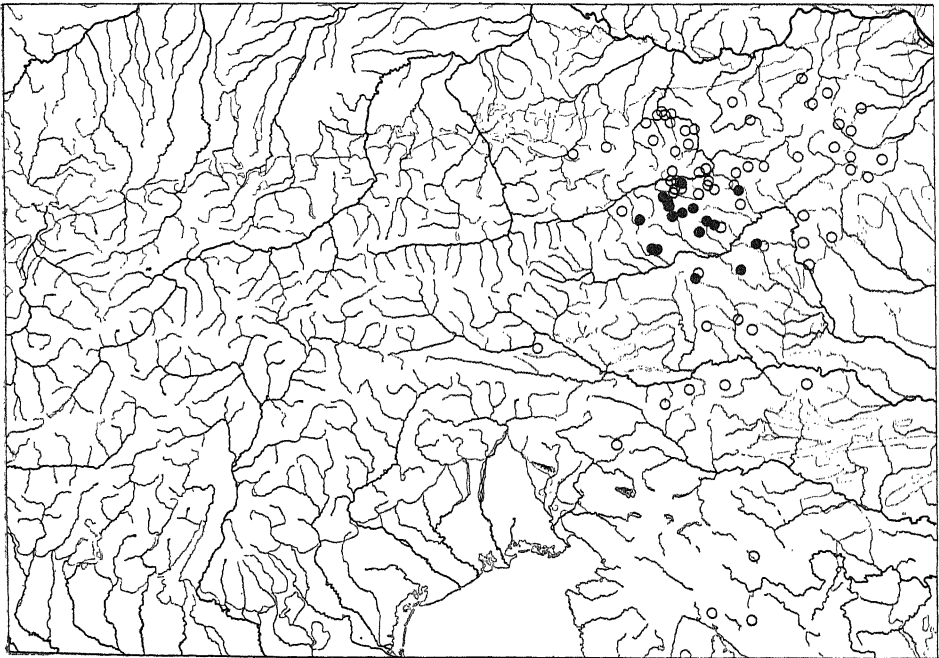


Karte 5: Verbreitung von *Pedilophorus auratus* Duftsch. (●), *Liosoma cyanopterus* Redtb. (○) und *Otiorrhynchus duinensis stenorostris* (Apfb. (▲) in den Ostalpen.

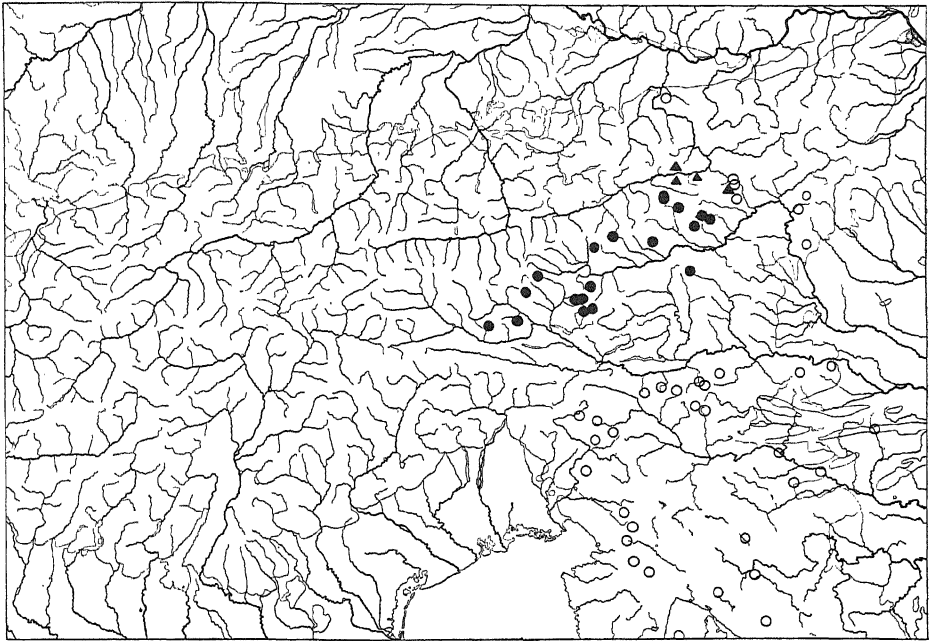
auch an solchen Stellen noch ihr Leben zu fristen, wo zwischen den Talgletschern und der eiszeitlichen Schneegrenze nur mehr bescheidene, aber doch noch von reichlicherer Vegetation bedeckte Räume zur Verfügung standen. Dem entsprechend erstreckt sich auch die Verbreitung beider Arten aus dem dauernd unvergletscherten östlichsten Teile des Gebirges noch ein Stück gegen das Alpeninnere. Noch klarer kommt der Unterschied zwischen den Verbreitungsbildern hochalpiner und denen nur tiefere Lagen bevölkernder Gebirgstiere in Karte 7 zum Ausdruck. Die in dieser Karte durch schwarz ausgefüllte Kreise dargestellte Verbreitung von *Crepidodera simplicipes* Kutsch., einer an Urgestein gebundenen, an alpinen Zwergweiden lebenden Art, erstreckt sich über einen Teil der östlichsten Zentralalpen westwärts bis weit in das von eiszeitlichen Talgletschern erfüllte Gebiet, ist jedoch offensichtlich auf solche Punkte beschränkt, an denen auch während der Vereisungsmaxima noch dauernd mit einer ausreichenden Vegetation bedeckte Flächen zur Verfügung standen. Ganz anders liegen die Verhältnisse bei *Orestia alpina* Germ. (leere Kreise), einer subalpinen Art, welche die obere Grenze geschlossener Zwergstrauchbestände heute kaum überschreitet. *Orestia alpina* zeigt ein Verbreitungsbild, welches sich an dasjenige der in Karte 2 bis 5 dargestellten Arten anschliesst. *Psylliodes subaenea styriaca* Hktgr. (schwarz ausgefüllte Dreiecke)

<sup>3</sup> Der westlichste der vier in Karte 8 verzeichneten Fundorte von *Amara nobilis* ist irrig. Eingehende von K. Holdhaus durchgeführte Ermittlungen haben ergeben, dass die Art auf der Veitschalpe nicht vorkommt. Dagegen habe ich die Art inzwischen auf dem Gippel festgestellt.

ist ein extremes Relikt, welches in Schneekaren der subalpinen Stufe an *Hutchinsia alpina* L. lebt. In Karte 8 ist die Verbreitung dreier weiterer hochalpin lebender Käferarten dargestellt. Die schwarz ausgefüllten Kreise bedeuten das Vorkommen der auf Urgestein beschränkten *Amara alpicola* Dej., die leeren Kreise dasjenige der vikariierend auf Kalk lebenden *Amara cuniculina* Dej. Beide Arten leben hochalpin, steigen jedoch talwärts auch noch in die Zwergstrauchstufe und in lichte Felsenheiden zwischen Krummholz herab. Ihre Lebensweise befähigt sie noch heute, sich an solchen Stellen dauernd zu halten, wo nur kümmerliche Vegetation auf beschränktem Raume zur Verfügung steht. Damit hängt zusammen, dass die Verbreitung von *Amara alpicola* in den Zentralalpen weit nach dem intensiv vergletscherten Westen übergreift und auch *Amara cuniculina* in den nördlichen Kalkalpen im eiszeitlich intensiv vergletscherten Salzkammergut an einzelnen weithin isolierten Punkten vorkommt. Es gibt allerdings auch Beispiele dafür, dass ausschliesslich hochalpin lebende Arten durch die eiszeitliche Vergletscherung der Alpen auf kleine Reliktareale zurückgedrängt wurden. *Amara nobilis* Duftsch., deren Verbreitung auf Karte 8 mit schwarzen Dreiecken dargestellt wurde, ist ein solches extremes Relikt. Auch die Verbreitung subalpin lebender Arten ist bisweilen in mehrere weit isolierte Verbreitungsinseln zerrissen. Ein Beispiel dafür ist in Karte 9 dargestellt. Die ausschliesslich hochsubalpine Lagen besiedelnde *Chrysochloa elongata* Suffr. zerfällt nach neuen Untersuchungen von S. Ruffo und mir in vier Rassen, von denen die Subspezies *styriaca* m. (in Karte 9 mit schwarz ausgefüllten Kreisen dargestellt) die östlichsten Zentralalpen und wahrscheinlich auch noch die Kalkhochalpen Oberkrains in einer Reihe voneinander zum Teil weit isolierter



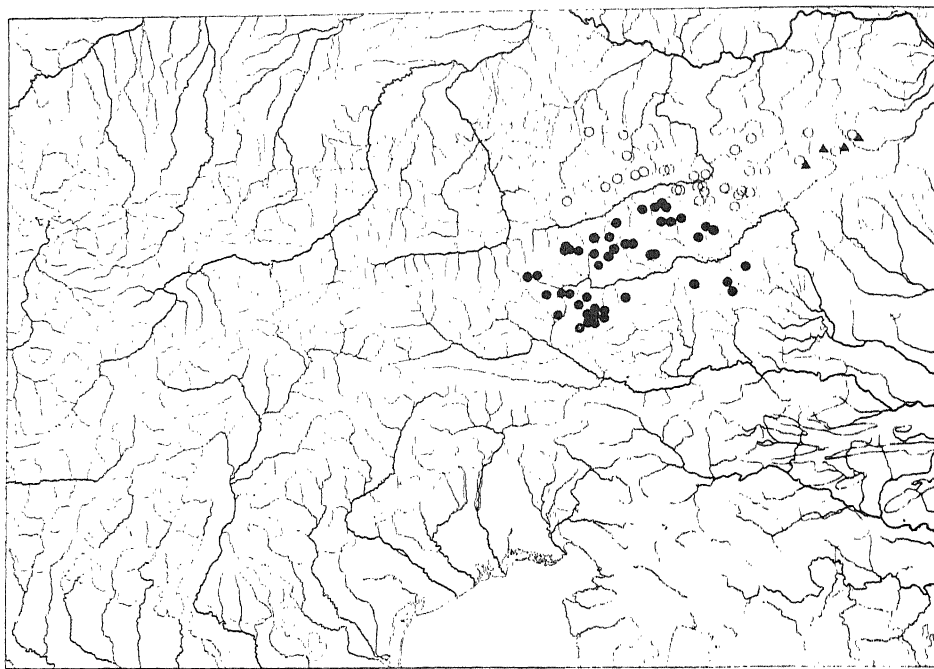
Karte 6: Verbreitung von *Sclerophaedon carnolicus* Germ. (○) und *Chrysomela lichenis abena* Germ. (●) in den Ostalpen.



Karte 7: Verbreitung von *Crepidodera simplicipes* (●) Kutsch. (●), *Orestia alpina* Germ. (○) und *Psylliodes subaenea styriaca* Hktgr. (▲) in den Ostalpen.

Populationen bevölkert, während die Stammform im Hochgebirge der Sette Comuni auf beschränktem Raume (vgl. leere Kreise der Karte) häufig und von zahlreichen Sammlern gefunden wurde. Eine weitere Rasse, ssp. *ruffoi* m., ist in den Hochalpen der Schweiz und Piemonts ziemlich weit verbreitet, während ssp. *occidentalis* Ruffo in den Westalpen an zahlreichen Punkten südwärts bis in die Alpes maritimes nachgewiesen ist. Die beiden ostalpinen Rassen der Art sind streng auf das Gebiet beschränkt, welches dauernd ausserhalb der Grenzen der eiszeitlichen Talgletscher gelegen war. Sie besiedeln dieses Gebiet jedoch heute nicht mehr zusammenhängend, sondern wurden durch die pleistozänen Klimaschwankungen jedenfalls schon früh in weit auseinanderliegende Refugien gedrängt, wo sie sich bereits zu besonderen geographischen Rassen differenzierten.

Die vorgeführten Beispiele stellen nur eine kleine Auswahl aus der ansehnlichen Reihe von Reliktarten dar, die wir heute innerhalb der Bodenfauna der Nordostalpen und zwar nicht nur unter den Käfern, sondern auch aus anderen Tiergruppen kennen. Leider ist eine ausführlichere Darstellung des gesamten Tatsachenmaterials im Rahmen eines Kurzvortrages unmöglich; sie wird in meiner in Vorbereitung befindlichen tiergeographisch-biozönologischen Monographie der Osthälfte der Nordostalpen nachgetragen werden. Es sei jedoch gestattet unter Mitberücksichtigung der unveröffentlichten Unterlagen aus den dargelegten Beispielen einige historisch-tiergeographische Schlussfolgerungen zu ziehen.



Karte 8: Verbreitung von *Amara alpicola* Dej. (●), *A. cuniculina* Dej. (○) und *A. nobilis* Duftsch. (\*).

Es kann heute kein Zweifel mehr darüber bestehen, dass nicht nur in den Südalpen, sondern auch am Ost- und Nordrand des Alpenzuges neben hochalpinen auch auf tiefere Gebirgslagen beschränkte Kleintierarten das gesamte Pleistozän überdauert haben. Die strenge Beschränkung der Verbreitung dieser Arten auf das dauernd unvergletscherte Gebirge kann zusammen mit der bei mehreren von ihnen nachgewiesenen Isolierung in einzelnen voneinander weit getrennten Verbreitungsinseln nur als Folge der eiszeitlichen Alpenvergletscherung gedeutet werden. Das Verbreitungsbild dieser Relikte ist von dem der zahlreichen postglazialen Rückwanderer, die teils in breiter Front<sup>4</sup>, teils entlang der Talfurchen nach dem Abschmelzen der Gletscher wieder mehr oder weniger weit in das devastierte Gebiet zurückgewandert sind, auf den ersten Blick zu unterscheiden.

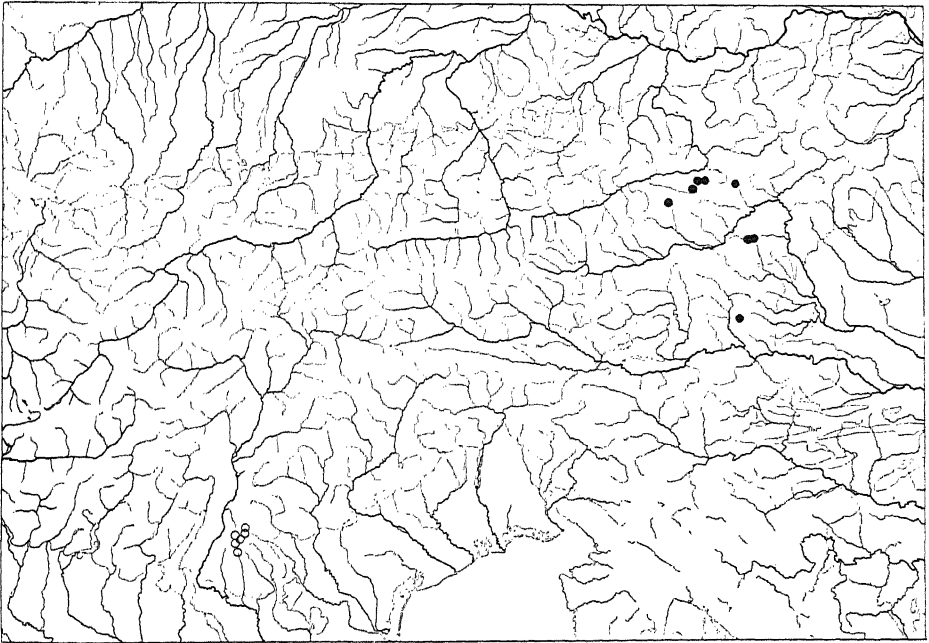
Der Vergleich der Verbreitungsbilder der die tieferen Gebirgslagen bevölkernden Reliktarten lässt deutlich mehrere offensichtlich ökologisch bedingte Typen erkennen. Diese Verbreitungstypen verdienen eine eingehendere Besprechung, da ihre Analyse zu bemerkenswerten Schlussfolgerungen führt.

Einen dieser Verbreitungstypen repräsentieren jene Arten, die heute nicht nur subalpine, sondern auch hochalpine Lagen bevölkern. Ein hierher gehöriges, auf unserer Karte dargestelltes Beispiel ist *Sclerophaedon carniolicus*; es sind von Käfern aber

<sup>4</sup> Man vergleiche zum Beispiel die Verbreitungsbilder von *Trechus alpicola* Strm., *limacodes* Dej. und *rotundipennis* Duftsch., die auf Karte 5 in meiner Arbeit „Die Landtierwelt der mittleren Hohen Tauern, ein Beitrag zur tiergeographischen und -soziologischen Erforschung der Alpen“, Denkschr. Akad. Wiss. Wien, mat.-nat. Kl. 107, 1943, dargestellt sind.

auch noch zahlreiche andere wie *Trechus pinkeri* Gglb., *Otiorrhynchus megerlei* F., *Tropiphorus globatus* Hbst. und *styriacus* Bed. hierher zu zählen. Diese Arten besitzen ein durch zahlreiche Funde belegtes und meist recht zusammenhängendes Verbreitungsgebiet in dem eiszeitlich dauernd unvergletscherten östlichsten Teile der Alpen und sind ausserdem von einigen wenigen, zum Teile ziemlich weit auseinanderliegenden Punkten innerhalb des Areals der eiszeitlichen Talgletscher bekannt. Diese Einzelpunkte liegen fast stets oberhalb des eiszeitlichen Talgletscherniveaus, so dass die betreffenden Arten dort an Ort und Stelle das Pleistozän überdauert haben können. Die isolierten westlichen Vorkommnisse sind jedenfalls von der eiszeitlichen Vergletscherung übriggelassene Reste eines ursprünglich grösseren Verbreitungsgebietes, dessen durch die Eiszeitgletscher nicht unmittelbar betroffener östlicher Teil bis heute ein geschlossenes Wohngebiet geblieben ist.

Ein anderer Typus wird durch *Platynus scrobiculatus*, *Aptinus bombardaria*, *Pedilophorus auratus* und weniger ausgeprägt durch *Laena viennensis* repräsentiert. Bei diesen Beispielen handelt es sich um Käferarten, deren Verbreitungsgrenze mit derjenigen der eiszeitlichen Talvergletscherung weitgehend zusammenfällt. Es muss hervorgehoben werden, dass alle hierher gehörenden Arten heute nur unterhalb der Waldgrenze vorkommen und jedenfalls auch während des Pleistozäns nicht in einem hochalpinen Klima zu leben vermochten. Für sie bestanden nur dort während des ganzen Pleistozäns ausreichend günstige Lebensbedingungen, wo zwischen der eiszeitlichen Schneegrenze und dem Talboden ein breiter Höhengürtel für die Entfaltung von Vegetation und Fauna zur Verfügung stand. Sie mussten dagegen überall dort der devastierenden



Karte 9: Verbreitung von *Chrysochloa elongata styriaca* Franz (●) und *Chrysochloa elongata elongata* Suffr. (○).

Wirkung der eiszeitlichen Klimaverschlechterungen zum Opfer fallen, wo mächtige Gletscherströme die Talböden erfüllten.

Ausser den beiden besprochenen gibt es noch einen dritten Verbreitungstypus, der dadurch ausgezeichnet ist, dass seine Vertreter erst in einem erheblichen Abstände von den Endmoränen der grossen Eiszeitgletscher gefunden werden. Hierher gehören von den besprochenen Arten *Sipalia flava*, *Bythinus longulus*, *Cephennium carpathicum* und *Otiorrhynchus duinensis stenorostris*. Es sind das durchwegs bodenbewohnende Käfer, die in der Gegenwart nur Waldböden tieferer Gebirgslagen bevölkern und daher besonders hohe Ansprüche an Klima und Vegetation stellen. Ihre räumlich beschränkte Reliktverbreitung ist offensichtlich die Folge des Umstandes, dass sie auch unmittelbar ausserhalb der Grenzen der eiszeitlichen Fernvergletscherung keine ihnen zusagenden Standortverhältnisse antrafen. Wahrscheinlich haben wir es hier mit Tieren zu tun, die auch während der ungünstigsten Klimaperioden des Pleistozäns mindestens eine Vegetation von Krummholzcharakter beanspruchten und sich nur dort erhalten konnten, wo eine solche während der Vereisungsmaxima bestand. Für Arten, die heute in unmittelbarer Nachbarschaft der eiszeitlichen Endmoränen leben, mag auch eine üppige Zwergstrauchvegetation, in der wir noch heute oberhalb der alpinen Waldgrenze typische Waldbodentiere finden, ausgereicht haben.

Diese Schlussfolgerungen mögen gewagt erscheinen, sie haben aber ihre Parallelen in den Ergebnissen der nordeuropäischen biogeographischen Forschung. Für die skandinavische Fauna hat Lindroth schon im Jahre 1938 in einem Vortrage, den er am VII. Internationalen Kongress für Entomologie gehalten hat<sup>5</sup>, nachgewiesen, dass in Fennoskandien in unmittelbarer Nähe der würmzeitlichen Gletschermassen nicht bloss an ein arktisches Klima angepasste Käferarten, sondern auch solche die letzte Eiszeit überdauert haben müssen, die heute in Nordeuropa niemals oberhalb der Waldgrenze angetroffen werden. In letzter Zeit sind die Forschungen Lindroths, die dieser inzwischen durch Beibringung eines umfangreichen Tatsachenmaterials weiter unterbaut hat, durch eingehende Untersuchungen Beirnes über den Ursprung und die Geschichte der britischen Grossschmetterlingsfauna<sup>6</sup> ergänzt worden. Auch Beirne kommt zu dem Ergebnis, dass verhältnismässig wärmebedürftige Schmetterlingsarten auf den britischen Inseln unweit des diese in der Riss- und Würmzeit bedeckenden Eisschildes mindestens das Jungpleistozän überdauert haben. Auch bei diesen phytophagen Insekten war das nur möglich, wenn gleichzeitig mit ihnen eine ihren Ansprüchen genügende Vegetation die Maxima der Vergletscherung überdauert hat.

Wir haben bisher im ostalpinen Randgebiet nur solche Arten der Bodenfauna besprochen, die als montane Endemiten das gesamte Pleistozän an Ort und Stelle überdauert haben müssen. Dass es neben Relikten der tertiären Gebirgsfauna auch solche gibt, die sichtlich erst während der Quartärzeit, sicher aber bereits vor der letzten Grossvereisung der Alpen ihre heutigen Standorte in diesen besiedelt haben, kann nur noch kurz angedeutet werden. So ist *Chrysomela crassicornis* Hellies.<sup>7</sup> in den Alpen wie in Südnorwegen, Nordschottland, den Shetlands- und Orkneyinseln zweifellos ein Würmüberwinterer. Die extreme Isolierung kleiner Populationen dieser Art in den Alpen an steilen Süd- und Südwesthängen über dem Niveau der würmzeitlichen

<sup>5</sup> Lindroth, C. H., Die skandinavische Käferfauna als Ergebnis der letzten Vereisung. VII. Internationaler Kongress für Entomologie, Berlin 1938, p. 240—267.

<sup>6</sup> Beirne, B. P., The Origin and History of the British Macro-Lepidoptera. Trans. Roy. Entom. Soc. London 98, 1947, p. 273—372.

<sup>7</sup> Franz, H., Revision der Verwandtschaftsgruppe der *Chrysomela gypsophilae* Küst. (Coleopt., Chrysom.) Entom. Bl., 34, 1938, p. 190—210, 249—273.



Talgletscher und die Bildung junger Rassen sprechen eindeutig dafür, dass die Art als interglazialer Einwanderer durch die Wirkungen einer neuen Grossvergletscherung an zahlreiche extreme Reliktstandorte zurückgedrängt wurde. Dort hat infolge einer immerhin schon lange andauernden Isolierung eine Differenzierung in bereits unterscheidbare Rassen begonnen.

Es ist bemerkenswert, dass aus dem östlichsten Teile der Alpen einzelne Pflanzenarten, die als xerophil und im gewissen Sinne auch als thermophil bezeichnet werden müssen, von einer kleinen Anzahl von Reliktstandorten in von der Stammform deutlich abweichenden jungen Rassen oder schon zu selbständigen Arten entwickelt bekannt sind. Derartige Beispiele sind *Alyssum motanum preissmanni* Baumg. und *Anemone styriaca* Hay. Es muss angenommen werden, dass auch diese endemischen Pflanzenformen mindestens die Würmeiszeit an Ort und Stelle überdauert haben, womit die Feststellung verbunden ist, dass relativ viel Wärme beanspruchende Organismenarten wenigstens die letzte Eiszeit im östlichsten Teile der Alpen an Ort und Stelle überlebten. Leider ist derzeit das Studium der Rassenbildung bei thermophilen Insekten, die im ostalpinen Raum an extrem isolierten Standorten leben, noch wenig weit fortgeschritten. Es ist jedoch durchaus möglich, dass sich auch an den Populationen von *Pedinus femoralis* L. auf dem Häuselberg bei Leoben, von *Crypticus quisquilius* L. und *Polyergus rufescens* Latr. auf dem Serpentinberge der Gulsen bei Kraubath und des Tausendfüßlers *Dignathodon microcephalus* Luc. auf der Peggauer Wand, Arten, die durchwegs bisher nur von einem einzigen Standorte im Bereiche des steirischen Murtales bekannt sind, junge Rassenbildung wird nachweisen lassen. Eine solche ist kürzlich bereits bei dem verhältnismässig wärmeliebenden Laufkäfer *Cymindis coadunata* Dej. von Schatzmayr<sup>8</sup> durch Beschreibung der Subspezies *orientalis* Schatzm. festgestellt worden.

Wir stehen in der historisch-tiergeographischen Analyse der Alpenfauna heute trotz vieler bereits geleisteter Detailarbeiten immer noch in den Anfängen. Entscheidende Fortschritte werden wir auf diesem Gebiete erst erzielen können, wenn die junge Rassenbildung bei einer entsprechend grossen Zahl die Alpen bewohnender Arthropodenarten eingehend untersucht sein wird. Es ist darum dringend zu wünschen, dass sich die Entomologie in Zukunft noch mehr als das immerhin in den letzten Jahren bereits der Fall war, dem Studium der geographischen Rassen widmet. Rasche Fortschritte können auf diesem Gebiete allerdings nur durch internationale Zusammenarbeit erzielt werden. Möge die Zukunft einer solchen Zusammenarbeit günstiger sein, als es die jüngste Vergangenheit gewesen ist.

## VERZEICHNIS ZU DEN IN DEN KARTEN ANGEgebenEN FUNDORTEN

*Aptinus bombardaria* Illig (Karte 2).

Niederösterreich: Bisamberg (A. Winkler i. l.); Stiefern i. Kamptal (lg. Minarz); Alauntal bei Krems (lg. Bachinger); Klosterneuburg (Winkler i. l.); Weidlingau und Pressbaum (Winkler i. l.); Rekawinkel (coll. Pinker); Herzogenburg (lg. Grundmann); Perchtoldsdorf (coll. Curti); Wildeggen b. Heiligenkreuz (lg. Wimmer); Sparbach b. Mödling (lg. Grätz); Brühl b. Mödling (lg. Ganglbauer); Baden (lg. Wingelmüller); Fischau (coll. Franz); Hohe Wand und Gutenstein (lg. Wingelmüller); Pitten (lg. Ganglbauer); Kranichberg (lg. Ganglbauer); Edlach b. Reichenau (coll. Minarz); Schneeberg (Winkler i. l.); Semmeringgebiet (lg. Sturany); Rabenstein

<sup>8</sup> Schatzmayr, A., Appunti coleotterologici XIV. Rivista Sci. Nat. „Natura“ 35, 1944: p. 117—134.

(lg. Franz); Waidhofen a. Ybbs (lg. Bachinger); Opponitz (lg. Pachole); St. Peter i. Au (lg. Pachole); Ernstshofen b. Steyr (lg. Petz).

Oberösterreich: Damberg b. Steyr (lg. Petz); Grünburg (lg. Petz); Leonstein (lg. Petz); Trattenbach und Wendbach (lg. Petz); Ennsleiten b. Ternberg (lg. Wirthumer); Weyer gegen Wildegg (lg. Sadleder); Schoberstein (lg. Petz); Almkogel (lg. H. Priesner); Micheldorf (teste Heberdey-Meixner); Klaus (teste Heberdey-Meixner); Stoder (lg. Petz); Warscheneckgebiet, am Weg von Spital zum Linzerhaus (lg. M. Priesner); Kasberg gegen Grünau (lg. H. Priesner); Gmunden (lg. Praxmarer); Kremsmünster (lg. M. Priesner); Pfenningberg b. Linz (lg. M. Priesner); Puchenu (lg. Kloiber); Petrinumwald und Bachl b. Urfahr (lg. Gschwendtner); Prägarten (Winkler i. l.).

Niederbayern: Passau (lg. Kittel, teste Horion).

Steiermark: Krampen i. Mürztal (Stöcklein i. l.); Kindberg (coll. Petz); Hochlantsch (lg. J. Meixner); Teichalpe (coll. Weber); Peggau (lg. Franz); Graz (lg. Weber); Hörgas (lg. Wallaberger); Oberzeiring (teste Kiefer); Eisenerz (teste Grundmann); Lugauer, Aufstieg durch den Waggraben (lg. M. Priesner); Gams b. Hiefalau (lg. Kiefer); Noth b. Gams (lg. Franz).

Burgenland: Geschriebensteingipfel (lg. Franz); Faludital b. Rechnitz (lg. Franz).

Kärnten: St. Paul (lg. Winkler); Wolfsberg (lg. Winkler); Sattnitz (teste Holdhaus-Prossen); Eisenkappel (lg. Hopp); Obir (Winkler i. l.); Grafensteiner Alm, Obirgebiet (lg. Hölzel); Ferlach (teste Holdhaus-Prossen); Bärensgraben unter der Golica (lg. Hölzel); Bleiberg am Dobratsch (teste Prossen); Dobratschgebiet subalpin (teste Schatzmayr); Krainberg b. Arnoldstein (teste Holdhaus-Prossen).

Jugoslawien: Veldes (lg. Sadleder); Planina (teste Grundmann); Umgebung Laibach (lg. Stöcklein); Nanos (lg. Ganglbauer); Ternovanerwald (teste Müller); Lipizza (teste Müller); Matajur und Umg. Volzano (teste Müller); S. Lucia (teste Müller); Conca di Orleg (teste Müller); S. Canzian und Opicina (teste Müller); Mte. Maggiore (teste Müller); Sesana (lg. Sadleder); Mte. Nevoso b. Fiume (teste Müller); Fuzine (coll. Breit); Velebit (coll. Tax); Delnice, grosse Capella (teste Stöcklein).

Italien: Umg. Triest (coll. Frey, coll. Breit).

#### *Platynus scrobiculatus* F. (Karte 2).

Niederösterreich: Kamptal (lg. Minarz); Wien, Dornbach (lg. Wingelmüller); Kritzendorf (lg. Pachole); Kahlenberg und Kobenzel (teste Horion); Rekawinkel (lg. Wingelmüller); Kaltenleutgeben und Giesshübl (coll. Curti); Rossgipfel b. Heiligenkreuz (lg. Franz); Hainfeld (coll. Curti); Höllental (lg. Sadleder); Kranichberg a. Wechsel (lg. Ganglbauer); Purgstall (lg. Pachole); St. Peter i. d. Au (lg. Pachole); Scheinoldstein und Opponitz (lg. Pachole); Lunz (teste Grundmann); Kleinwien (lg. Bachinger).

Oberösterreich: Damberg b. Steyr (lg. Petz); Schoberstein und Wendbach (lg. Petz); Reichraming und Almkogel (lg. Petz); Stubau b. Weyer (lg. Franz); Oberlaussa, Holzgraben (lg. Franz); Sengsengebirge, Südhang b. Windischgarsten (lg. Franz); Vogelsangklamm b. Spital a. Phyrn (lg. Wirthumer); Obermicheldorf (lg. Wirthumer); Hochsalm (lg. M. Priesner); Pfenningberg und Hornbachgraben b. Linz (lg. M. Priesner).

Bayern: Passau (teste Ihssen); Hoher Göll (lg. Stöcklein); Berchtesgaden (coll. Breit); Ruhpolding, Disselbach (lg. Stöcklein).

Steiermark: Kindberg (coll. Petz); St. Erhard gegen Dornerkogel (lg. Franz); Bärenschützklamm (lg. Franz); Peggau (lg. Sadleder); Graz (coll. Weber); Gleinalpe (coll. Weber); Oberdorf b. Voitsberg (coll. Konschegg); nördlich von Wies (coll. Konschegg); Bärndorf (lg. Moosbrugger); Pürgschachen gegen Pyhrn (lg. Moosbrugger); Mühlauer Wasserfall b. Admont (lg. Franz); Hartelsgraben b. Hieflau (lg. Franz); Lugauer (teste Wirthumer); Noth b. Gams (lg. Franz); Schwabertal nächst Grünbauer (lg. Franz).

Burgenland: Steinbach b. Lockenhaus und Faludital b. Rechnitz (lg. Franz).

Kärnten: Wolfsberg (lg. Winkler); Krassnitz b. Zweinitz (teste Hölzel); Zweinitz i. Gurktal (teste Moosbrugger); auf der Sattnitz b. Grafenstein, Gurnitz und Viktring (teste Hölzel); Ossiacher Tauern, Techelweg (teste Hölzel); Obir (lg. Frey); Koschuta (lg. Hölzel); Warmbad Villach (lg. Sadleder); Dobratsch (teste Hölzel); Bleiberg und Arnoldstein (teste Schatzmayr); Teufelsgraben (teste Schatzmayr); Mittagkogel (lg. Franz); Sachsenburg (lg. Holdhaus).

Jugoslawien: Bachergebirge (lg. Ganglbauer); Franz (coll. Breit); Loibltal (coll. Breit); Wochein (lg. Wingelmüller); Laibach (lg. Stussiner); Gottschee (coll. Kaufmann); Divlja jama b. Plava (teste Müller); Adelsberg (teste Müller); Val Branizza b. S. Daniele (teste Müller); Val Recina und Mte. Nevoso (teste Müller); Grotte von S. Canžian (teste Müller); Foiba di Pisino und Mte. Maggiore (teste Müller); Fuzine (lg. Ganglbauer); Capella (lg. Ganglbauer); Sljemen planina (lg. Franz).

*Laena viennensis* Sturm (Karte 3).

Niederösterreich: Leithagebirge b. Mannersdorf (lg. Holdhaus); Leithagebirge b. Wimpassing (lg. Franz); Hermannskogel b. Wien (lg. Kniz); Sievering (lg. Winkler); Wien, Dornbach (lg. Wingelmüller); Hütteldorf (coll. Curti); Tullnerbach (coll. Curti); Rekawinkel (lg. Ganglbauer); Pressbaum (lg. Gylek); Mödling (coll. Curti); Baden und Vöslau (coll. Curti); Kaumberg (coll. Plason); Pitten und Wechselgebiet (lg. Ganglbauer); Kirchberg a. Wechsel (lg. Beier); Kranichberg a. Wechsel (lg. Ganglbauer); Schneeberg (coll. Wingelmüller).

Oberösterreich: Ennsauen b. Enns (teste Hölzel); Umg. Steyr (lg. Troyer); Dürnbach b. Enns und Damberg (lg. Petz); Wendbach und Grosse Dirn (lg. Petz); Grünburg (lg. Petz).

Steiermark: Turnau (lg. Moczariski); Josergraben nächst Bodenbauer, Hochschwabsüdseite (lg. Wimmer); Bruck a. Mur (lg. Franz); St. Erhard gegen Dornerkogel (lg. Franz); Mühlbachgraben b. Rein (lg. Franz); Thal b. Graz (lg. Sadleder); Ruine Gösting b. Graz (lg. Franz); Lannach b. Graz (lg. Moosbrugger); Koralmpe (coll. Winkler); Tobelbad (coll. Winkler); Wernersdorf (coll. Konschegg); Wies und Radel b. Eibiswald (lg. Konschegg); Mahrenberg (lg. Konschegg); Windische Bühel b. Spielfeld-Strass (teste Hölzel); Raabklamm b. Weiz (lg. Franz); Gössgraben b. Leoben (lg. Franz); St. Michael (lg. Moosbrugger); Liesingtal zwischen Mautern und Kammern (lg. Moosbrugger); Schiltern b. Oberwölz (lg. Franz); Schinderwald b. Neumarkt (lg. Handstanger).

Burgenland: Neudorf b. Wiener Neustadt (lg. Moczariski); Geschriebenstein b. Rechnitz (lg. Franz).

**Kärnten:** Friesach (coll. Kaufmann); Zweinitzbach i. Gurktal (teste Moosbrugger); Klagenfurter Becken, in Eichenwäldchen (teste Hölzel); Grafenstein, Sattnitz (teste Hölzel); Ossiach (lg. Sturany); Bad Vellach (lg. Sadleder); Eisenkappel und Obir (lg. Moczarski); Loibelpass (teste Hölzel); Bärental, Karawanken (coll. Winkler); Villach (lg. Holdhaus); Dobratsch (teste Hölzel); Heilige Wand (teste Hölzel). **Osttirol:** Lienz, Schlossberg (coll. Strobl); Amlach b. Lienz (lg. Konieczni). **Jugoslawien:** Bachergebirge und Marburg a. Drau (teste J. Meixner); Sanntal (lg. Kreckich); Wochein (lg. Ganglbauer et Pinker); Feistritzquelle b. Stein (lg. Wingelmüller); Umg. Laibach (lg. Gspan); Rosenbach (lg. Gspan); Iwancica (coll. Frey); Krapina (lg. Hensch); Otocac (coll. Kaufmann); S. Canzian (lg. Seseck); Fuzine (lg. Ganglbauer); Capella (coll. Kaufmann); Ternovannerwald (lg. Kreckich). **Italien:** Cervignano (lg. Pinker); Vallarsa (lg. Ganglbauer); Euganeen (lg. Holdhaus et Moczarski).

*Sipalia flava* Kr. (Karte 3).

**Niederösterreich:** Kranichberg und Kirchberg a. Wechsel (lg. Ganglbauer). **Steiermark:** Stuhleck (teste Bernhauer); Mehlstübelgraben b. Veitsch (lg. Leitner); Bruck a. Mur (lg. Franz); Turnau (lg. Moczarski); Donawitz (lg. Franz); Gössgraben b. Leoben (lg. Franz); Ingeringtal b. Ingeringsee (lg. Franz); St. Erhard gegen Dornerkogel (lg. Franz); Mixnitz (coll. Pinker); Bärenschtzklamm b. Mixnitz (lg. Franz); Hochlantsch (lg. Franz); Peggau, am Fuss der Wand (lg. Franz); Admonter Höhe b. Weinzödl und Ruine Gösting b. Graz (lg. Franz); Schöckl b. Graz (teste Bernhauer); Mühlbachgraben und St. Oswald b. Rein (lg. Franz); Lannach und Plabutsch b. Graz (coll. Konecny); Oberdorf b. Voitsberg (coll. Konecny); St. Radegund (lg. Becsedes); Bruckkogel b. Graz (coll. Winkler).

*Bythinus longulus* Kiesw. (Karte 4).

**Steiermark:** Turnau (lg. Moczarski); Bodenbauer, Hochschwab-Südseite (lg. Wimmer); St. Erhard gegen Dornerkogel (lg. Franz); Gössgraben b. Leoben (lg. Franz); Preg b. Kraubath (lg. Franz); Gulsen b. Kraubath (lg. Franz); Mühlbachgraben b. Rein (lg. Franz); Bärenschtzklamm b. Mixnitz (lg. Franz).

**Kärnten:** Eisenkappel (coll. Breit); Wildensteiner Wasserfall, Obir Nordseite (lg. Schweiger); Vellacher Kocna und Loibtal (lg. Schweiger); Bodental (lg. Stangl); Petzen und Uschowa (lg. Schweiger) Proboj und Gösselsdorf (lg. Schweiger); St. Stephan und Presseggen i. Gailtal (lg. Schweiger); Egger Forst b. Hermagor und Südhang der Vellacher Egel (lg. Schweiger).

**Jugoslawien:** Bachergebirge (teste Meixner); Weissenfels (coll. Breit); Wochein (lg. Bernhauer); Cerna prst (coll. Breit); Umg. Laibach (coll. Mus. Linz); Umg. Franz (coll. Breit); Nanos (coll. Breit); Gottschee (lg. Ganglbauer); Berge b. Skrad (coll. Breit); Capella und Fuzine (coll. Breit).

**Italien:** Bosco di Cansiglio (coll. Breit); Mte. Cavallo (lg. Holdhaus); Valarsa (lg. Ganglbauer); Val di Ledro (lg. Ganglbauer); Cima Tombea (lg. Pinker); Creto (lg. Ganglbauer).

*Cephenium carpathicum* Saulcy (Karte 4).

**Niederösterreich:** Lobau b. Wien (lg. Moczarski); Korneuburg und Bisamberg (coll. Breit); Kaltenleutgeben (coll. Breit et Curti); Frauenstein b. Mödling und Anningergebiet (lg. Franz); Brühl (lg. Pachole); Umg. Baden (lg. Holdhaus);

Vöslau (coll. Breit); Merkenstein b. Vöslau (lg. Franz); Pitten (lg. Ganglbauer).  
 Steiermark: Schneealpe (lg. Wimmer); Donawitz (lg. Franz); Bruck a. Mur (lg. Franz); Peggau, am Fuss der Wand (lg. Franz); Weinzödl b. Graz; Rein, Eingang des Mühlbachgrabens, (lg. Franz); Schöckl (lg. H. Priesner); Graz, Schlossberg (lg. Praxmarer).

*Pedilophorus auratus* Duftsch. (Karte 5).

Niederösterreich: Schönbühel (coll. Curti); Pressbaum (lg. Pazourek); Reka-winkel (lg. Ganglbauer); Hainfeld (coll. Curti); Kirchberg a. d. Pielach (coll. Curti); Pitten (lg. Ganglbauer); Kirchberg a. Wechsel und Kranichberg (lg. Ganglbauer); Edlach b. Payerbach (coll. Curti); Lunz (lg. Strenzke).

Oberösterreich: Damberg b. Steyr (lg. Franz); Zwieselbachgraben b. Klein-reifling (lg. Franz); Kreuzberg und Stubau b. Weyer (lg. Franz); Oberlaussa, Holz-graben (lg. Franz); Kleiner Priel Südhang (lg. Franz).

Steiermark: Schwarzenbachgraben, Zirnitz und Mühlau b. Admont (lg. Franz); Buchsteingebiet, Brucksattel (lg. Franz); Kalblinggatterl, Gesäusealpen (lg. Franz); Geierbichel b. Admont (lg. Franz); Selztal und Bärndorf (lg. Moos-brugger); Hochhaide (lg. Moosbrugger); Hartelsgraben, Gesäusealpen (lg. Franz); Kaiserschild, Kalte Fözl (lg. Franz); Waggraben b. Hieflau (lg. Franz); Hoch-schwabgebiet, Fowiesalm (lg. Franz); Gösseck (lg. Franz); Leopoldsteinersee (lg. Franz); Mühlbachgraben b. Rein (lg. Franz); Umg. Graz (lg. Praxmarer); Weiz-klamm (lg. Franz); Koralpe (lg. Wingelmüller).

Burgenland: Geschriebenstein, Gipfelgebiet (lg. Franz).

Kärnten: Metnitztal (teste Klimesch); Jovanberg (lg. Paganetti); Obir und Petzen (lg. Schweiger); Vellacher Kocna (lg. Schweiger); Latschur und Feldberg (lg. Konschegg); Spitzegel (lg. Schweiger).

Jugoslawien: Marburg a. Drau (coll. Konschegg); Bachergebirge (lg. Gangl-bauer); Umg. Cilli (lg. Franz); Umg. Tüffer und Römerbad (lg. Franz); Triglav-gebiet (lg. Pachole); Wochein (lg. Ganglbauer); Cerna prst (lg. Ganglbauer); Weis-senfels (lg. Wingelmüller); Gottschee (lg. Ganglbauer); Kocen b. Gottschee (lg. Franz); Umg. Laibach (lg. Praxmarer); Tervanenerwald (lg. Schweiger); Fuzine und Grosse Capella (lg. Schweiger).

Italien: Mte. Cavallo (lg. Holdhaus); Cima Posta (lg. Ganglbauer); Malga della Borcola nördl. Vallarsa (teste Bertolini); Valsugana (teste Bertolini); S. Lugano nördl. des Fleimsertales (teste Bertolini); Malga della Mojetto (teste Halbherr); Rollepäss (lg. Ganglbauer); Karersee (lg. Ganglbauer); Bozen (teste Horion).

*Liosoma cyanopterum* Redtb. (Karte 5).

Niederösterreich: Schneeberg (lg. Otto); Rax (lg. Schweiger).

Oberösterreich: Oberlaussa, Holzgraben (lg. Franz); Sengsengebirge, Süd-seite der Hohen Nock (lg. Franz).

Steiermark: Haller Mauern, Aufstieg zur Griesweber-Hochalm (lg. Franz); St. Gallen gegen Buchau (lg. Franz); Umg. Grossreifling (teste Kiefer et Moosbrug-ger); Gams b. Wiefrau (teste Kiefer et Moosbrugger); Noth b. Gams (lg. Franz); Hartelsgraben, Gesäusealpen (lg. Franz); Johnsbach, unweit oberhalb Donnerwirt (lg. Franz); Admont gegen Kaiserau (lg. Franz); Frein gegen Hinteralm (lg. Franz); Wechselgebiet (lg. Ganglbauer); Hochlantsch (lg. Ganglbauer); Gleinalpe, Speik-

kogel (lg. Franz); Stubalpe (coll. H. Priesner, coll. Weber); Koralpe (lg. Ganglbauer); Zirbitzkogel (teste Kiefer et Moosbrugger).  
Jugoslavien: Bachergebirge (lg. Ganglbauer).

*Otiorrhynchus duinensis stenorostris* Apfb. (Karte 5).

Oberösterreich: Wendbach und Schoberstein (lg. Petz); Grosse Dirn und Losenstein (lg. Petz); Molln (lg. Munganast); Grünau (lg. Munganast).  
Steiermark: Ragnitztal b. Graz (lg. Penecke).  
Kärnten: Jowanberg (coll. Winkler).  
Jugoslavien: Marburg a. Drau (lg. Penecke); Gottschee (coll. Mus. Wien); Fuzine (coll. Mus. Wien); Pola (coll. Mus. Wien).

*Sclerophaedon carniolicus* Germ. (Karte 6).

Niederösterreich: Gutenstein (lg. Schweiger); Schneeberg (lg. Ganglbauer); Semmering (coll. Pachole); Kirchberg a. Wechsel (lg. Ganglbauer); Rax (coll. Curti); Türritzer Höger und Reisalpe (coll. Curti); Kirchberg a. Pielach (coll. Curti); Schwarza u. Gebirge (coll. Curti); Lunz (coll. Breit); Not b. Ybbsitz (coll. Pinker).  
Oberösterreich: Trattenbach und Schoberstein (lg. Petz); Wendbach und Grosse Dirn (lg. Petz); Pfaffenboden b. Ternberg (lg. Troyer); Almkogel und Bodenwies (lg. Petz); Kleinreifling (lg. Petz); Oberlaussa, Holzgraben (lg. Franz); Molln (lg. Munganast); Sengsengebirge, Hohe Nock (lg. Petz); Almsee (lg. Pachole); Hohe Schrott (lg. M. Priesner).

Steiermark: Gumpen b. Öblarn (teste Kiefer et Moosbrugger); Frauenberg und Schmidbacher Moor b. Admont (lg. Franz); Zirmitz b. Admont (lg. Franz); Bärndorf (lg. Moosbrugger); Admonter Kalbling, subalpin (lg. Franz); Leobner, Nordhang (lg. Franz); Hartelsgraben und Gstatterstein Südhang, Gesäusealpen (lg. Franz); Tamischbachturm (lg. Moosbrugger), Waggraben b. Hieflau (lg. Franz); Sulzkarhund, Gesäusealpen (lg. Kiefer); Erzberg gegen Eisenerzer Reichenstein und Achnergraben b. Radmer (lg. Franz); Gösseck, oberstes Kaisertal (lg. Franz); Oberzeiring (teste Kiefer et Moosbrugger); Seckauer Zinken (lg. Ganglbauer); Hochschwab, Westseite, am Weg von der Neuwaldeggalm zur Sonnschianalm und am Ebenstein hochalpin (lg. Franz); Hochschwab (lg. Mariani); Hohe Veitsch, subalpin (lg. Leitner); Stuhleck (coll. Breit); Hochwechsel (coll. Pittioni); Hochlantsch (lg. Ganglbauer); Umg. Peggau (lg. Praxmarer); Umg. Graz (lg. Konschegg); Gleinalpe, Nordhang des Speikkogels (lg. Franz); Weizklamm (lg. Franz); Zirbitzkogel (coll. Breit); Koralpe (lg. Ganglbauer).

Kärnten: Wolfsberg (lg. Christen); Saualpe (lg. Holdhaus); Obir und Petzen (lg. Schweiger); Loiblpass (lg. Schweiger); Feldberg und Siefplitzgraben (lg. Konschegg).

Jugoslavien: Bachergebirge (lg. Ganglbauer); Gottschee (lg. Ganglbauer); Cerna prst (coll. Pinker); Fuzine (coll. Breit); Capella (lg. Ganglbauer et Bernhauer).

*Chrysomela lichenis ahena* Germ. (Karte 6).

Steiermark: Admonter Kalbling (lg. Franz); Eisenerzer Reichenstein (lg. Kloiher et Moosbrugger); Seckauer Zinken und Hochreichard (lg. Franz); Himmeleck (lg. Kiefer); Geierkogel (lg. Franz et Kiefer); Bruderkogel und Grosser Bösenstein

(lg. Franz); Dreisteckengipfel (lg. Franz); Hochhaide (lg. Moosbrugger); Steinermandl (lg. Kiefer); Schreindl, Donnersbacher Alpen (lg. Franz); Schiesseck (lg. Székessy); Schiesseck, Zinkengipfel (lg. Franz); Zirbitzkogel (lg. Kiefer); Stubalpe (lg. Kanschegg); Gleinalpe, Speikkogel (lg. Franz).

*Crepidodera simplicipes* Kutsch. (Karte 7).

Steiermark: Seckauer Zinken (lg. Ganglbauer); Hochreichard (lg. Franz); Pletzen (lg. Meixner); Geierkogel (lg. Franz); Dreisteckengipfel (lg. Franz); Hochhaide (lg. Moosbrugger); Schiesseck, Zinkengipfel (lg. Franz); Süßleiteck (lg. Székessy); Preber (lg. Franz); Zirbitzkogel (teste Daniel).

Kärnten: Hafnereckgruppe, oberstes Pöllatal und Gössgraben (lg. Holdhaus); Nockgruppe, Peitlernock, Pressingnock und Mallnock (lg. Holdhaus); Kreuzeckgruppe, Salzkofel und Kreuzelhöhe (lg. Holdhaus).

*Orestia alpina* Germ. (Karte 7).

Oberösterreich: Damberg b. Steyr (lg. Petz).

Das einzige Belegstück von diesem Fundort befinden sich in der Sammlung des Linzer Museums. Es trägt am Originalfundortzettel des Sammlers eine genaue Datumangabe. Da Petz zum angegebenen Zeitpunkt an keinem anderen Fundort der Art gesammelt hat, ist eine Fundortverwechslung kaum möglich. Petz war einer der genauesten Sammler, so dass seine Fundortangaben einen hohen Grad von Glaubwürdigkeit besitzen.

Steiermark: Gsollalm b. Eisenerz (lg. Franz); Eisenerzer Reichenstein (lg. Petz); Gösseck, oberstes Kaisertal (lg. Franz); Dornerkogel, Fischbacher Alpen (lg. Franz); Hochlantsch (lg. Franz et Ganglbauer).

Kärnten: Petzen (lg. Ganglbauer); Eisenkappel und Uschowa (lg. Gobanz); Koschuta (lg. Leonhard); Stougebiet (lg. Ganglbauer); Bodental (lg. Otto).

Jugoslawien: Umg. Marburg a. Drau (lg. Gspan et Krauss); Bachergebirge (lg. Ganglbauer et Krauss); Steiner Alpen (lg. Ganglbauer); Cerna prst (lg. Ganglbauer); Wochein (lg. Ganglbauer); Ternovannerwald (lg. Ravasini); Kobilja glava b. Tolmein (lg. Ravasini); Ratschach (lg. Gspan); Soca östl. Flitsch (teste Heikertinger); Krapina (lg. Hensch); Berge b. Skrad (lg. Winkler); Uremizza (lg. Springer); Lescovac südl. Karlovac (lg. Hopfgarten); Gurkfeld (lg. Gspan); Gottsche (lg. Ganglbauer); Nanos (lg. Springer); St. Canzian (teste Heikertinger); Matera, Istrien (lg. Springer); Fuzine (lg. Ganglbauer); Capella (lg. Bernhauer et Ganglbauer); Castelnuevo, Istrien (lg. Stussiner).

*Psylliodes subaenea styriaca* Hktr. (Karte 7).

Steiermark: Kalblingboden, Gesäusealpen (lg. Franz); Geäusealpen, Tellersack am Hochtor (lg. Franz et Pinker); Eisenerzer Reichenstein (lg. Klobner).

*Amara alpicola* Dej. (Karte 8).

Steiermark: Petererriegel und Ameringkogel (teste Heberdey et Meixner); Stubalpe (teste Heberdey-Meixner); Zirbitzkogel (lg. Franz); Seckauer Zinken und Hochreichard (lg. Franz); Geierkogel (lg. Franz); Pletzen (lg. J. Meixner); Bruderkogel und Grosser Bösenstein (lg. Franz); Hochhaide und Steinermandl (teste Kiefer-Moosbrugger); Hochschwung und Hochgrössen (teste Kiefer-Moosbrugger); Schütt-

kogel (lg. Moosbrugger); Schiesseck (lg. Székessy); Schiesseck, Zinkengipfel (lg. Franz); Krautwasch (lg. Franz); Talkenschrein (lg. Székessy); Gumpeneck (teste Kiefer et Moosbrugger); Grosser Knallstein (lg. Butschek); Süsseiteck (lg. Székessy); Predigtstuhl (lg. Franz); Breuner Feldeck (lg. Wanke); Preber (lg. Franz); Hading (lg. Holdhaus); Lungauer Kalkspitz (Holdhaus); Pranker Höhe (lg. Székessy); Giglachsee (lg. M. Priesner); oberstes Göriachtal (lg. Wanke).

Salzburg: Tappenkar (lg. Leeder); Weisseck gegen Riedingscharte (lg. Mandl). Kärnten: Eineck östl. Katschberg und Stubeck (lg. Holdhaus); Eisenhut (lg. Holdhaus); Gaipahöhe (lg. Holdhaus); Gregerle Nock (lg. Reiter); Kaserhöhe b. Turrach (lg. Holdhaus); Kilnprein (lg. Bucheder); Grosser Rosennock (lg. Holdhaus); Mallnock und Klomnock (lg. Székessy); Tschanek (lg. Holdhaus); oberstes Pöllatal, Hafnereckgruppe (lg. Holdhaus); Mühlhauser Nock (lg. Holdhaus).

*Amara cuniculina* Dej. (Karte 8).

Niederösterreich: Schneeberg und Rax (coll. Curti); Göller (teste Heberdey-Meixner); Dürrenstein (lg. Beier); Hochkar (lg. Ebner).

Oberösterreich: Sengsengebirge, Hohe Nock (lg. Franz); Kremsmauer (lg. Franz); Kleiner Priel (lg. Franz); Traunstein (lg. Franz); Warscheneck (lg. M. Priesner); Gjaidalm, Dachsteingebiet (lg. H. Priesner).

Steiermark: Hohe Veitsch (lg. Kühnelt); Hochschwabgipfel (lg. Franz); Ebenstein (lg. Franz); Hochturm, Trenchtling (lg. Franz); Polster (teste Heberdey-Meixner); Eisenerzer Reichenstein (lg. Franz); Gösseck (lg. Franz); Keiserschild (lg. Franz); Zeyritzkaupl (lg. Franz); Leobner (lg. Franz); Stadelfeld und Umg. Heschütte am Hochtor (lg. Franz); Hochzinödl (lg. Stich); Admonter Kalbling und Sparafeld (lg. Franz); Tamischbachturm und Grosser Buchstein (lg. Franz); Haller Mauern, Scheiblingstein und Grosser Pyhrgas (lg. Franz); Hochmöbling (teste Kiefer-Moosbrugger); Totes Gebirge, Tragl und Lawinenstein (lg. Franz).

*Amara nobilis* Duftsch. (Karte 8).

Niederösterreich: Schneeberg (lg. Franz); Rax (lg. Wimmer).

Steiermark: Schneecalpe (lg. Holdhaus).

*Chrysochloa elongata styriaca* Franz (Karte 9).

Steiermark: Oberstes Sulzkar und obere Koderalm in den Gesäusealpen (lg. Franz); Nordhang des Leobner (lg. Franz); Vordernberger Reichenstein (teste Breit); Umg. Scheiplsee Rottenmanner Tauern (lg. Wimmer); oberstes Übelbachtal und Nordhänge der Rossbachalpe, Gleinalpengebiet (lg. Franz); Koralpe (lg. Tiesenhäuser).

Kärnten: Grosses Kor, Koralpengebiet b. Wolfsberg (lg. Wimmer).

*Chrysochloa elongata elongata* (Suffr.) Ruffo (Karte 9).

Italien: Mte. Passubio (coll. Franz); Col Santo (coll. Mus. Linz); Cima posta (lg. Pinker); Campo grosso (lg. Holdhaus); Vallarsa (lg. Bertolini); Valle die Revolto, Cima Galbana, Passo della Pertica und Le Gozze (teste Ruffo); Gruppo della Caregna (teste Ruffo).



## DIE ARTENZUSAMMENSETZUNG OSTALPINER UND PANNONISCHER BODENTIERGEMEINSCHAFTEN IN IHRER ABHÄNGIGKEIT VOM STANDORT

Von *H. Franz*

Während bereits zahlreiche Untersuchungen über die Abhängigkeit der Besatzdichte verschiedener Böden mit terricolen Tieren vorliegen, ist unsere Kenntnis von der Artenzusammensetzung der Bodenfauna und ihrer Abhängigkeit vom Standort (Habitat) immer noch recht gering. Es rührt das daher, dass die Zahl der in der Erde lebenden Kleintiere sehr gross und ihre Bestimmung sehr schwierig und zeitraubend ist. Schon die vollständige bodenzoologische Analyse einer einzigen grösseren Bodenprobe erfordert für das Auslesen und rohe Bestimmen der darin enthaltenen Kleintiere eine Arbeitsleistung von Wochen. Die genaue Determination aller im Boden enthaltenen tierischen Organismen ist aber überhaupt nur in Zusammenarbeit mehrerer Spezialisten zu bewältigen. Trotzdem müssen qualitative zoologische Bodenuntersuchungen in grösserer Zahl durchgeführt werden, denn nur durch sie lässt sich Einblick in die Gesetzmässigkeiten gewinnen, durch welche die Artenzusammensetzung der Bodenfauna bestimmt wird. Ich habe aus diesem Grunde seit einer Reihe von Jahren an der Bundesanstalt für alpine Landwirtschaft in Admont (Steiermark) im Rahmen umfassender bodenzoologischer Untersuchungen die Erforschung des Artenbestandes an terricolen Kleintieren in seiner Abhängigkeit von Boden und Standort in Österreich in Angriff genommen und möchte ihnen in gedrängtester Form über einige Ergebnisse dieser Arbeiten berichten. Eine ausführliche Darstellung der bisher durchgeführten Untersuchungen ist im Manuskript fertiggestellt und wird hoffentlich bald in Buchform erscheinen können.<sup>1</sup>

Die Unterlagen lieferten bodenzoologische Analysen von über tausend Standorten, die zumeist in den österreichischen Alpen, zu einem kleinen Teile aber auch im pannonischen Klimagebiet im Osten Österreichs gelegen sind. Die Bearbeitung des ausserordentlich umfangreichen Tiermaterials, das aus dieser grossen Zahl von Bodenproben ausgelesen wurde, ist noch nicht abgeschlossen und bei den einzelnen Tiergruppen recht verschieden weit gediehen. Sie förderte zahlreiche für die Wissenschaft neue Arten zu Tage und konnte nur durch selbstlose, zum Teil jahrelange Mitarbeit einer Reihe von Spezialisten durchgeführt werden.

Von den untersuchten Böden liegen nunmehr umfangreiche Artenlisten vor, die es gestatten auf Grund von Charakterarten, die für bestimmte Standortverhältnisse kennzeichnend sind und mit Hilfe der Artenverbindung, in der sie auftreten, standortscharakteristische Bodentiersynusien zu unterscheiden.

Eine eingehende Besprechung derselben ist im Rahmen eines Kurzvortrages unmöglich. Ich muss mich daher im folgenden darauf beschränken, diejenigen Standortsfaktoren kurz zu erörtern, die nach unseren Erfahrungen die Verbreitung der einzelnen Bodentierarten entscheidend beeinflussen und im Anschluss daran einen Überblick über die von uns festgestellten Bodentiergemeinschaften zu geben.

Als für die Artenzusammensetzung der Bodentiergemeinschaften ausschlaggebendster Faktorenkomplex haben sich die Klimafaktoren erwiesen. Mittelwert und Schwankungs-

<sup>1</sup> Inzwischen befindet es sich als Buch mit dem Titel „Bodenzologie als Grundlage der Bodenpflege“ im Akademieverlag G. m. b. H. in Berlin im Druck.

bereich der Bodenfeuchtigkeit entscheiden bei vielen Bodentieren an erster Stelle darüber, ob dieselben an einem bestimmten Standorte dauernd zu leben vermögen oder nicht. Durch ihre Auswirkung auf die Feuchtigkeit haben mittelbar auch alle jene Klimafaktoren, die wie Wind und Wärme die Verdunstung steigern, auf das Bodenleben einen wesentlichen Einfluss. Infolge der verschiedenen Temperaturreaktion der einzelnen Organismenarten hat der Temperaturgang besonders in den oberen Bodenschichten auch unmittelbar eine starke selektive Wirkung. Am wenigsten wäre eine solche von den Belichtungsverhältnissen zu erwarten, da das Licht ja nur auf die Oberfläche des Bodens unmittelbar einwirkt. Dennoch haben auch die Belichtungsverhältnisse eines Standortes für die Zusammensetzung seiner Bodenbiozönose eine so grosse Bedeutung, dass das Vorhandensein oder Fehlen bestimmter Bodentiergruppen in erster Linie von dem Lichtgenuss des betreffenden Standortes abhängt.

Zwischen dem Binnenklima von Waldbeständen und dem Freilandklima bestehen grosse Unterschiede. Das Waldbinnenklima ist vom Freilandklima durch ausgeglichenen Temperaturgang, starke Herabsetzung der Verdunstung und geringe Belichtung verschieden. Das extremste Waldklima weisen Laubwälder, besonders Buchenaltbestände mit geschlossenem Kronendach auf. Das dichte Blätterdach der Kronen fängt in ihnen alle Strahlung ab und setzt nach Geiger<sup>2</sup> die Tagesschwankung der Temperatur im Mittel um fast 5° C gegenüber dem Freiland herab. Nach vergleichenden Messungen, die Schubert<sup>3</sup> durchgeführt hat, betrug die Verdunstung im Stammraum eines Fichten- und Kiefernwaldes 48 %, im Buchenwald gar nur 42 % derjenigen im benachbarten Freilande. Der Lichtgenuss der am Waldboden wachsenden Schattenpflanzen beträgt nach Lundegårdh<sup>4</sup> selten mehr als ein Hundertstel, häufig nur wenige Tausendstel des freien Himmelslichtes.

Danach ist es nicht zu verwundern, dass zwischen der Artenzusammensetzung der Bodenfauna schattiger, feuchter Wälder und derjenigen offenen, windausgesetzten Geländes der denkbar grösste Gegensatz besteht. In den Alpen tritt dieser oftmals zwischen dichten Waldbeständen und sonnigen Felsenheiden auf engem Raume zutage. Die Tiergemeinschaften, die beide besiedeln, sind so grundverschieden, dass nur eine kleine Anzahl vollkommen standortindifferenter Ubiquisten beiden gemeinsam ist.

Die Unterschiede im Standortsklima kommen aber nicht nur bei der Gegenüberstellung der Extreme im Artenbestand der Bodentiergemeinschaften zum Ausdruck, sondern finden auch in der Zusammensetzung der Bodenbiozönosen verschiedener Waldtypen noch einen deutlichen Niederschlag. So beherbergen die feuchten und schattigen Laubmischwälder eine ganz andere Bodentiergemeinschaft als die lichten und auch bei reichlichen Niederschlägen leicht austrocknenden Heidewälder. Zwischen beiden Extremen vermitteln Nadelhochwälder, lichte Laubgehölze und alle örtlichen Varianten, die infolge verschiedener Bestandesdichte, Exposition, Geländeneigung und Bodenbeschaffenheit innerhalb eines jeden noch so einheitlichen Waldbestandes auftreten.

Neben den Klimafaktoren übt der Nahrungsfaktor auf die Artenzusammensetzung der Bodentiergemeinschaften einen starken Einfluss aus. Die Nahrungsgrundlage des tierischen Lebens im Boden bildet die darin enthaltene organische Substanz. Zu dieser zählen die lebende Wurzelmasse der höheren Pflanzen und die Körpermasse der im

<sup>2</sup> Geiger, R., Das Klima der bodennahen Luftschicht. Die Wissenschaft Bd. 78. 2. Aufl., Braunschweig 1942, XVI u. 435 S.

<sup>3</sup> Schubert, J., Verdunstungsmessungen an der Küste, im Flach- und Berglande, in Nadel- und Buchenwäldern. Verh. klimatol. Tagung Davos 1925, Basel 1925, 39 S.

<sup>4</sup> Lundegårdh, H., Klima und Boden in ihrer Wirkung auf das Pflanzenleben, Jena 1930, X u. 480 S., 2 Karten.

Boden lebenden Mikroben, ferner der gesamte pflanzliche Bestandesabfall, die tierischen Abfallstoffe und schliesslich der zu Humus im weitesten Sinne umgewandelte organische Anteil der Bodenmasse selbst. Den Organismen ist nicht jede Art von organischer Nahrung bekömmlich, vielmehr bevorzugen die einen diese, die anderen jene Substanzen und viele Tierarten sind auf ganz bestimmte organische Abfallstoffe oder Beuteorganismen spezialisiert. Art und Menge der im Boden zur Verfügung stehenden organischen Massen beeinflussen auf diese Weise die Zusammensetzung des Artenbestandes der Bodentiergemeinschaften stark. Von besonderer Bedeutung für das Bodenleben ist nach unserer Erfahrung der Grad der Zersetzbarkeit des pflanzlichen Bestandesabfalles. Laubstreu wird im allgemeinen eichter zerkleinert und verdaut als Nadelstreu, Erlen-, Hasel- und Ahornstreu leichter als Eichen- und Rotbuchenstreu, Bestandesabfall guter Wiesengräser und Kräuter leichter als solcher stark verkießelter oder verholzter und daher harter Wiesenpflanzen. Je leichter pflanzlicher Bestandesabfall zu zerkleinern und zu verdauen ist, umso grösser ist die Zahl der Arten, die sich daran beteiligen, ihn zu verzehren.

Die Vegetation übt so durch die Art des Bestandesabfalls, den sie produziert, unmittelbar auf die Zusammensetzung der Bodentiergemeinschaften einen starken Einfluss aus. Eine andere Art der Einflussnahme besteht in der Mitbestimmung des Bestandesklimas, sodass zwischen Vegetation und Bodenleben enge Wechselbeziehungen bestehen.

Weniger tiefgreifend ist der Einfluss, den physikalische und chemische Eigenschaften des Substrates auf die Zusammensetzung der Organismengemeinschaften des Bodens nehmen. Dennoch bilden sandige, lehmige oder tonige Beschaffenheit des Oberbodens, Säuregrad und Kalkgehalt, Natrongehalt der Salzböden, Wasserundurchlässigkeit und hoher Grundwasserstand wichtige Standortsfaktoren, durch welche die Artenzusammensetzung der Bodensynusien merklich beeinflusst wird.

Im Gebirge ist auch die Höhenlage des Standortes nicht ohne Wirkung auf die Synökologie der Bodentiere. Abgesehen davon, dass die Artenmannigfaltigkeit der Bodenfauna mit zunehmender Seehöhe abnimmt, entsprechen verschiedenen Höhenstufen im Gebirge bestimmte für sie bezeichnende Bodentierarten. Wir kennen unter den terricolen Tieren der Alpen zahlreiche Beispiele streng an hoch- oder subalpine Lagen gebundener Formen und auch solcher Arten, welche die untere Grenze der subalpinen Region nach oben nicht überschreiten.

Nach diesen allgemeinen Feststellungen möchte ich Ihnen nun an Hand einer Tabelle einen ersten Überblick über die in den österreichischen Alpen festgestellten Bodentiergemeinschaften geben. In der Tabelle wurden nicht einzelne Arten, sondern nur die Artenzahlen, mit denen die grossen Bodentiergruppen in den einzelnen Synusien vertreten sind, verzeichnet. Mit Rücksicht darauf, dass unsere Untersuchungen noch im Flusse sind und die hier mitgeteilten Ergebnisse nur eine Zwischenbilanz noch laufender Arbeiten darstellen, unterlasse ich es absichtlich, die einzelnen Synusien schon jetzt durch ihre Leitformen und ihre charakteristische Artenverbindung zu beschreiben. Ich möchte vielmehr zunächst nur unter Beweis stellen, dass es durch ihren Formenbestand deutlich voneinander abweichende Bodentiergemeinschaften gibt und dass deren Artenzusammensetzung weitgehend standortsbedingt ist. Die in der Tabelle angeführten Präsenzzahlen stellen noch keine endgültigen Werte dar. Die meisten von ihnen werden sich im Laufe weiterer Untersuchungen noch erhöhen, meist allerdings nicht mehr wesentlich, sodass die Zahlen als Vergleichswerte durchaus brauchbar sind. Wo infolge einer zu geringen Menge bearbeiteter Bodenproben noch stärkere Erhöhungen erwartet werden müssen, ist in der Tabelle vor die betreffende Zahl ein + Zeichen gesetzt worden.

In Fällen, in denen das Material aus der betreffenden Tiergruppe noch nicht bearbeitet ist, wurde der Vermerk „n. b.“ gemacht.

Betrachten wir nun den Einfluss der verschiedenen Standortsfaktoren auf die Artenzahlen, mit denen die einzelnen Tiergruppen in bestimmten Biotopen vertreten sind und beginnen wir mit den Klimafaktoren. Der Einfluss des Faktors Feuchtigkeit kommt in der Präsenzzahl vor allem bei solchen Tiergruppen zum Ausdruck, deren terricole Vertreter überwiegend hygrophil sind. Dies ist bei den Landschnecken, Tausendfüsslern und Asseln der Fall. Alle drei Gruppen sind am artenreichsten in den feuchten und schattigen Buchenwäldern vertreten, während ihre Zahl in den zeitweilig stark austrocknenden Heidewäldern und gar in Felsenheideböden sehr gering ist. Ein Vergleich der Artenlisten würde überdies zeigen, dass die Tiergemeinschaft der feuchten Buchenwaldböden viele hygrophile Formen aus nahezu allen Tiergruppen enthält, Spezies, die an weniger feuchten und nicht so gleichmässig temperierten Standorten vollkommen fehlen.

Die Faktoren Wärme und Licht lassen ihren Einfluss besonders in den Präsenzzahlen solcher Tiergruppen erkennen, die in ihrer Gesamtheit wärmebedürftig beziehungsweise heliophil sind. Solche Tiergruppen sind die Ameisen und die Tardigraden. Die ersteren sind in den schattigen, gleichmässig kühl temperierten Buchenwäldern nur mit drei Arten vertreten, die überdies nur ganz vereinzelt gefunden wurden, während die letzteren an schattigen Standorten im Buchenwaldboden völlig fehlen, aber bereits in der Moosdecke etwas besonnener Baumstämme in geringer Anzahl leben. Dagegen wurden in den sonnigen Heidewaldböden 10 Tardigraden- und 19 Ameisenarten nachgewiesen. Bei den Ameisen ist die Präsenzzahl in den Heidewäldern höher als in irgendeinem anderen Waldbiotop, was daher kommt, dass dort mehrere wärmebedürftige Formen leben, die an keinem anderen Waldstandorte vorkommen. Verhältnismässig gross ist auch die Zahl der in heliophilen Gehölzen festgestellten Ameisenarten, während diejenige der sonnigen Felsenheiden als des wärmsten Freilandbiotopes alle anderen Biotope um ein Vielfaches übertrifft. Auch das Kulturland (Acker und Grünland) ist ameiseneich, während die hochalpinen Lagen frei von Ameisen sind, da das rauhe hochalpine Klima das Wärmebedürfnis dieser Tiere nicht zu befriedigen vermag. Dass auch unter den Schnecken, Spinnen, Milben, Pseudoskorpionen und Käfern in den Alpen ausgesprochen heliophile Formen vorkommen, die ausschliesslich oder vorwiegend sonnige Standorte besiedeln, hebt den grossen Einfluss der Erwärmung des Bodens durch die Sonnenstrahlung auf die Zusammensetzung der Bodentiergemeinschaften noch stärker hervor.

Von dem Grade der Zersetzlichkeit des pflanzlichen Bestandesabfalles scheinen nur die Tardigraden und Collembolen weitgehend unabhängig zu sein. Ihr ökologisches Verhalten weicht dadurch, dass sie in Nadelwaldböden die höchsten Artenzahlen aufweisen, von allen anderen Bodentiergruppen auffällig ab. Dagegen weisen die Käfer in den Auwäldern und heliophilen Gehölzen, deren Bestandesabfall besonders leicht zersetzlich ist, die höchsten Präsenzzahlen auf<sup>5</sup>. Auch die grosse Menge der in diesen beiden Biotopen vorkommenden Asseln und Tausendfüssler sowie der in der Tabelle nicht verzeichnete Formenreichtum der Fliegenlarven<sup>6</sup> sind offenbar durch die leichte Verdaulichkeit der dargebotenen Nahrung bedingt. Schon wesentlich ungünstiger ist die Beschaffenheit des Bestandesabfalles der Buche, der sich darum auch vielfach in

<sup>5</sup> In der Zahl der aus den Auwaldböden angegebenen Käferarten sind auch die im Herbst und Frühling dort angetroffenen, in den Auböden überwintrenden Ufertiere mit inbegriffen.

<sup>6</sup> Die terricolen Fliegenlarven konnten nicht in die Tabelle aufgenommen werden, da sie ohne Züchtung der Imagines in den meisten Fällen nicht bis zur Spezies bestimmbar sind.

mächtigen Streulagen am Waldboden anhäuft. Der Buchenwald weist daher im Vergleich mit den heliophilen Gehölzen trotz des ausgeglicheneren Klimas eine Verminderung der Käfer- und vermutlich auch der Fliegenarten<sup>6</sup> auf. Noch auffälliger ist die Abnahme der Präsenzzahlen, wenn man die Kolonne der Buchen- und Laubmischwälder mit derjenigen der Nadelwälder tieferer Lagen vergleicht. Dabei muss berücksichtigt werden, dass sich die wesentlich schlechtere Beschaffenheit der Nahrung bei den Nadelwaldböden nicht nur in einer Verringerung der Artenzahlen, sondern auch in einer starken Abnahme der gesamten Besatzdichte des Bodens mit Kleintierindividuen auswirkt. Die Herabsetzung des Bodenlebens ist in diesem Falle allerdings zum Teile nicht nur eine Folge der ungünstigeren Nahrungsverhältnisse, sondern auch eine solche des schlechteren Bestandesklimas. Da die Nadelwälder tieferer Lagen in den Ostalpen meist durch künstliche Aufforstung reiner Fichtenbestände an natürlichen Buchen- oder Mischwaldstandorten entstanden sind, ist diese Verarmung der Bodenfauna eine sehr beachtliche Folge künstlicher Standortveränderungen durch den Menschen. Die natürlichen subalpinen Nadelwälder weisen dagegen günstigere bodenbiologische Verhältnisse auf, was teils auf starke Beimengung von Lärchen und reichlicheren Unterwuchs, teils auf das bedeutendere Seehöhe entsprechend feuchtere Standortklima und nicht zuletzt auch darauf zurückzuführen sein dürfte, dass das natürliche Gleichgewicht der Biozönose hier nicht künstlich gestört wurde.

Die Abnahme der Artenmannigfaltigkeit der Bodenfauna mit Zunahme der Seehöhe wird bei einem Vergleich von Laubwaldbeständen tieferer Lagen mit Grünerlenbeständen im Bereiche der Waldgrenze sichtbar. Obwohl die Grünerle einen leicht zersetzlichen Bestandesabfall liefert und ein verhältnismässig günstiges Bestandesklima besitzt, ist die Zahl der in Grünerlebenböden festgestellten Kleintiere aus allen Gruppen mit Ausnahme der lichtbedürftigen Tardigraden und Ameisen wesentlich geringer als in Buchen- und Laubmischwäldern tieferer Lagen. Bodenbiologisch weicht der Grünerlenbiotop überdies dadurch von den Laubwaldbiotopen tieferer Lagen ab, dass er zahlreiche subalpine Arten beherbergt, die in tieferen Lagen vollkommen fehlen. Auch die hochalpinen Grasheideböden zeigen gegenüber dem Kulturland in Bereiche der Dauersiedlungen eine Verminderung der Artenmannigfaltigkeit bei fast allen Tiergruppen. Die Abnahme geht so weit, dass einzelne Tiergruppen wie die Asseln und Ameisen im hochalpinen Grasheidengürtel überhaupt nicht mehr vertreten sind.

Ein Einfluss der physikalischen und chemischen Bodeneigenschaften auf die Terricola kann aus der Tabelle nicht unmittelbar entnommen werden, ist aber doch bei einzelnen Tiergruppen deutlich feststellbar. So kommen von den in hochalpinen Grasheideböden der Nordostalpen lebenden Käferarten 24 ausschliesslich auf kalkreicher, 16 ausschliesslich auf kalkarmer Gesteinsunterlage vor. Die Asseln, Tausendfüssler und ganz besonders die gehäusetragenden Schnecken sind auf kalkreichen Böden viel formenreicher vertreten als auf kalkarmen. Auch hinsichtlich der anderen Tiergruppen sind Unterschiede im Artenbestande zwischen kalkreichen und kalkarmen, besonders stark sauren Böden festzustellen.

Es lassen sich demnach unter den Verhältnissen der Ostalpen, bedingt durch Unterschiede im Standortklima, in der Vegetation, in der Höhenlage und in den physikalisch-chemischen Bodeneigenschaften verschiedene Bodentiergemeinschaften unterscheiden. Sie scharf gegeneinander abzugrenzen, exakt zu beschreiben und ihre Verbreitung im Gelände im einzelnen festzustellen, ist die Aufgabe weiterer Detailforschung. Dabei werden auch noch andere Bodentiergemeinschaften wie die der Moor- und Sumpfböden, die bei unseren Erörterungen unberücksichtigt blieben, mitzubearbeiten sein.

Wir haben uns bisher ausschliesslich mit Böden aus dem Alpenraume, einem trotz grosser lokaler Unterschiede im ganzen humiden Klimagebiete, befasst. Treten wir in Landschaften mit anderen Klimaverhältnissen über, dann vollziehen sich in der Artenzusammensetzung der Bodenfauna weitgehende Änderungen. Wie gross diese sind, zeigt ein Vergleich der Bodenfauna des österreichischen Alpengebietes mit derjenigen des pannonischen Klimabereiches im Osten Österreichs. Das pannonische Klima ist wesentlich niederschlagsärmer als das Durchschnittsklima der Alpen und stellt einen Übergang zum kontinentalen Steppenklima Südrusslands und des südlichen Innerasien dar. Ein Vergleich der im alpinen und im pannonischen Klimabereich lebenden Bodenfauna, den ich gemeinsam mit M. Beier<sup>7</sup> auf Grund der in beiden Gebieten durchgeführten bodenzoologischen Untersuchungen angestellt habe, ergab, dass von 350 bisher in pannonischen Böden Österreichs gefundenen Milbenarten bloss 168, das sind 48 %, auch in den humiden Alpenböden vorkommen. Bei anderen Tiergruppen sind die Unterschiede nicht ganz so gross, aber immerhin so beträchtlich, dass lange Listen entstehen, wenn man auf der einen Seite die nur im humiden Alpenklima vorkommenden auf der anderen die im pannonischen Klima lebenden terricolen Arten zusammenstellt.

Trotz dieser Unterschiede in der Gesamtfaua sind es aber im wesentlichen dieselben Standortsfaktoren, die im pannonischen wie im alpinen Klimabereich zur Heraufdifferenzierung verschiedener Bodentiergemeinschaften führen. Hier wie dort spielt der Gegensatz zwischen Freiland- und Waldbinnenklima eine entscheidende Rolle. Zwar fehlt im niederschlagsarmen Klima als Extrem der einen Seite schattiger und feuchter Laubwald, denn der pannonische Wald ist verhältnismässig sonnig und trocken, dafür aber finden sich auf der Seite der Freilandbiotope umso extremer xerotherme Standorte. Viel einschneidender als im humiden Bereich wirkt sich im pannonischen Klima der Einfluss des Grundwassers auf die Bodenfauna aus. Unter Grundwassereinfluss stehende Böden beherbergen ganz anders zusammengesetzte Bodentiergemeinschaften. Dies gilt in gleicher Weise für Wald- wie für Freilandbiotope.

Hinsichtlich der physikalischen Bodenbeschaffenheit nehmen die Sandböden biologisch eine Sonderstellung ein, hinsichtlich des Bodenchemismus aber die Salz-(Soda)-böden. Über die mehr oder weniger stark an Sandböden gebundenen psammophilen und die auf Salzböden beschränkten halophilen Arten enthält auch die ältere Literatur schon zahlreiche Angaben.

Der Einfluss der Kulturtätigkeit des Menschen auf die Bodenfauna ist im pannonischen Raume noch grösser als im alpinen. Dies ist eine Folge des Umstandes, dass ebene und hügelige Landschaften eine viel intensivere wirtschaftliche Nutzung des Bodens gestattet als das Hochgebirge. Weite ehemals bewaldete Flächen sind im pannonischen Klimabereich in Acker- und Weideland und damit in waldlose Kultursteppe verwandelt worden. Diese sekundäre Steppe beherbergt, obwohl sie heute ein der ursprünglichen Steppe recht ähnliches Standortsklima aufweist, doch eine von dieser verschiedene Bodenfauna. In der primären Steppe leben nicht nur in der Vegetationsschicht, sondern auch im Boden zahlreiche echte Steppentiere, die in die Kultursteppe nach deren künstlicher Entwaldung nicht übergewandert sind. Ich habe diese kulturfeindlichen Steppentiere „Kulturflüchter“ genannt<sup>8</sup>. Sie sind Charakterarten echter Steppenbiozöno-

<sup>7</sup> Franz, H. und M. Beier, Zur Kenntnis der Bodenfauna im pannonischen Klimagebiet Österreichs. II. Die Arthropoden. *Annal. nat. Mus. Wien*, 56, 1948.

<sup>8</sup> Vgl. u. a. Franz, H., Die thermophilen Elemente der mitteleuropäischen Fauna und ihre Beeinflussung durch die Klimaschwankungen der Quartärzeit. *Zoogeographica* 3, 1936, 159—320.

sen, durch welche diese von den Tiergemeinschaften der Kultursteppe scharf geschieden sind.

Wie im alpinen und im pannonischen Bereich, liessen sich auch schon in anderen Klimaprovinzen die Grundlinien ähnlicher Gesetzmässigkeiten aufzeigen, nach denen sich allenthalben deutlich unterscheidbare Bodenbiozöosen gegeneinander abgrenzen. Die verfügbare Zeit gestattet es leider nicht, dies zu tun. Die Absicht meiner Ausführungen war aber auch nicht, ein System der Bodentiergemeinschaften zu entwerfen, sondern die ökologischen Grundsätze aufzuzeigen, nach denen sich die Bodentierarten zu bestimmten Tiergemeinschaften zusammenfinden. Die Erkenntnis dieser Gesetzmässigkeiten ist ja eine der Voraussetzungen dafür, dass wir in die Lage versetzt werden, die Bodenorganismen künstlich zu beeinflussen und ihre für die Bodenfruchtbarkeit so wichtige Tätigkeit zu lenken. Die diesbezüglichen Forschungen dienen damit dem Zwecke, uns dem Ziele einer planmässigen Bodenpflege und Bodenverbesserung näherzubringen.

Zahl der Arten, durch welche die einzelnen Bodentiergruppen in verschiedenen Biotopen des Alpengebietes vertreten sind.

Tiergruppe	Anwaldböden der Gebirgsstär	Heliophile Gehölze tieferer Gebirgslagen	Ozeanische Buchen- und Laubmischwälder	Subalpine Grün- lenbestände	Nadelwälder tieferer Gebirgslagen	Nadelwälder subalpiner Lagen und subalpine Latschenbestände	<i>Erica carnea</i> -Heidewälder	Kulturland	Felsenheiden	Hochalpine Grastheiden	Hochalpine Schneeflächen
Nematoden	n. b.	n. b.	46	21	18	12	+ 3	60	11	42	36
Rotatorien	42	—	n. b.	n. b.	n. b.	n. b.	+	n. b.	20	n. b.	10
Turbellarien	5	—	11	n. b.	2	3	n. b.	1	n. b.	n. b.	n. b.
Enchytraeiden	5	4	+ 7	6	2	6	2	11	2	+ 8	5
Lumbriciden	+ 2	4	9	n. b.	n. b.	10	3	6	—	8	2
Schnecken	27	17	46	17	7	n. b.	14	24	+ 1	15	6
Milben	+46	52	229	n. b.	n. b.	+85	66	173	42	+85	38
Tardigraden	+ 2	+ 3	—	5	6	12	10	11	8	n. b.	8
Weberknechte	4	1	11	4	n. b.	2	6	—	—	2	5
Spinnen	9	11	23	4	7	10	8	11	17	21	1
Pseudoskorpione	4	6	4	2	3	5	3	—	2	—	—
Tausendfüssler	28	38	43	18	15	23	17	22	n. b.	23	7
Asseln	11	10	23	5	2	7	4	2	+ 1	—	—
Collembolen	36	+ 9	60	22	13	67	62	62	n. b.	42	24
Käfer	247	170	110	68	55	101	59	200	7	66 <sup>9)</sup>	38
Ameisen	8	15	3	4	2	+ 8	19	17	29	—	—

<sup>9)</sup> Anm.: Von diesen Arten finden sich auf Kalkgestein 50 (davon 24 ausschliesslich auf diesem), auf Urgestein 42 (16 ausschliesslich auf diesem).

## DISKONTINUIERLICHE OST—WEST-VERBREITUNG MITTELEUROPAISCHER KÄFER

Von *Ad. Horion*, Überlingen am Bodensee

Während die diskontinuierliche Nord—Süd-Verbreitung in der europäischen Zoogeographie unter dem Namen der boreoalpinen und boreomontanen Tiere allgemein bekannt ist, ist über eine diskontinuierliche Ost—West-Verbreitung noch kaum etwas veröffentlicht worden. Ich will deshalb zuerst einige markante Beispiele aus den mitteleuropäischen<sup>1</sup> Koleopteren herausstellen, um dieses interessante zoogeographische Problem vorzuführen.

1. *Staphylinus chloropterus* Panz., eine Art, die besonders in Wäldern an alten Stümpfen und Stämmen, im Mulm, unter Moos und Laub, an Baumschwämmen vorkommt. — Westareal: Frankreich von den Waldgebieten bei Compiègne, Fontainebleau und in Calvados bis zum Süden (Dép. Tarn und Var). — Ostareal: Von Südrussland über Siebenbürgen, Ungarn, Slowakei bis zum Böhmer Wald, den Ostalpen und Südtirol. Die Auslöschungszone schliesst den ganzen Südrand der Alpen (ausser Südtirol nicht in Nord-Italien!), Schweiz und Deutschland ein. Nach einer alten Quelle (Oertzen 1886) soll die Art auch in Griechenland vorkommen (Verbr.-Karte 1).

2. *Tachinus discoideus* Er. Westareal: Südfrankreich im Mittelmeergebiet von den Ostpyrenäen bis zu Westalpen, nördlich bis Gap und Lyon. — Ostareal: Slowakei bei Pressburg u. and. Fundorte, Mähren (Brünn), Österreich (Umg. Wien, Niederösterreich). Da die Art auch aus dem Kaukasus und aus Turkestan gemeldet wird, wird sie weiter nach Osten in Südrussland verbreitet sein. — Nach Roubal 1930 kommt die Art an xerothermen Hängen unter Steinen, unter abgeschälten Rinden, an Kadavern, in Pilzen, auch wohl in Nestern kleiner Säuger vor (V.-K. 2).

3. *Quedius vexans* Epp., ein Inquiline in Maulwurf- und Hamster-Bauen. Ostareal: Von Mittel-Deutschland (Thüringen, Mittelbe) bis zum Osten in Sachsen, Mark Brandenburg, Schlesien und Preussen; in West-Deutschland (Rhein- und Weser-Gebiet) ist die Art nicht vorhanden; Tschechoslowakei, Niederösterreich (Umg. Wien), Polen (genaue Verbreitung mir bisher unbekannt). — Westareal: Aus Frankreich sind bisher zwei Funde bekannt geworden aus montanem Gebiet: Basses-Alpes bei Larche (aus Marmeltierbau) und Puy-de-Dôme bei Sarcenat. Bei systematischen Untersuchungen von Kleinsäuger-Bauen wahrscheinlich häufiger zu finden (V.-K. 3).

4. *Omalium validum* Kraatz, eine phileophile Art, die sowohl aus natürlichen Höhlen, wie auch aus künstlichen Höhlen (Kleinsäuger-Baue) bekannt ist, meist in montanem Gebiet. — Ostareal: Siebenbürgen (Bucsecs in alpiner Lage), Karpathen in Ungarn und Slowakei, Beskiden und südl. Sudeten (Altvater und Glatzer Gebirge);

<sup>1</sup> Der zoogeographische Begriff „Mitteleuropa“ kann in zweifachem Sinne (sensu lato und sensu stricto) verstanden werden. Mitteleuropa sensu lato steht im Gegensatz zu Nord- und Süd-Europa und bezieht sich auf das weite Gebiet von Frankreich bis Mittel-Russland, das zwischen Nord- und Südeuropa gelegen ist. Mitteleuropa sensu stricto steht im Gegensatz zu West- und Ost-Europa und bezieht sich auf die Gebiete von Deutschland, Schweiz, Österreich, Tschechoslowakei, Ungarn etc. In der vorliegenden Arbeit handelt es sich um mitteleuropäische Käfer (s. l.), die von Frankreich bis Russland vorkommen, aber das eigentliche Nord- und Süd-Europa vermeiden, höchstens in die Grenzgebiete transgredieren.





1. *Staphylinus chloropterus* Panz.



2. *Tachinus discoideus* Er.



3. *Quedius vexans* Epp.



4. *Omalium validum* Kr.



5. *Euticonus conicicollis* Fairm.



6. *Stenichnus foveola* Rey. (compediensis Méc.)

Böhmische Mittelgebirge bis zur Sächsischen Schweiz; in Grotten in Istrien, Krain und Südingarn bis zu den Ostalpen in Kärnten und Niederösterreich, am Nordhang der Alpen in Salzburg und Tirol, westlich bis zu den Alpen im Allgäu, wo die Art noch in Murmeltier- und Dachs-Bauen gefunden wurde. — Westareal: Ostfrankreich von Isère und Auvergne im Süden bis zur Champagne und dem Maas-Gebiet im Norden; Luxemburg, Südbelgien und Südholland (nur in Süd-Limburg b. Maastricht u. Valkenburg); Deutschland: Rheinprovinz (Aachen, Eifel, Vallendar), Westfalen (Sauerland, Rothaargebirge), Harz (Bielshöhle, Claustal). — Auffallend ist bei dieser Art, dass sie in den nordwestdeutschen Gebirgen vom Rheinland bis zum Harz vorkommt, aber in so vielen südwest- und mitteldeutschen Gebirgen bisher völlig fehlt (Erzgebirge, Thüringer Wald (der besonders gut durchforscht ist!), Rhön, Taunus u. s. w.); die Höhlen des Fränkischen Jura sind von Prof. Stammer-Erlangen eingehend untersucht worden, ohne dass *Om. validum* gefunden wurde; eine Meldung für den Schwarzwald ohne genauen Fundort und Samler (nach Luze 1906) muss deshalb als sehr zweifelhaft bezeichnet werden; die Art fehlt bisher auch in den Vogesen, im französ.-schweizerischen Jura; aus der Schweiz bisher nicht gemeldet (V.-K. 4).

*Familie Scydmaenidae.* Die angeführten vier Arten kommen in alten hohlen Stämmen und Stümpfen vor, meist bei *Lasius*-Arten.

5. *Euticonus conicicollis* Fairm. Westareal: Frankreich (Compiègne, Fontainebleau, Collioure, teste Normand 1938). — Ostareal: Dänemark (Dyrehaven), Ostdeutschland (Harz, Mark Brandenburg, Mittelbe, Südost-Bayern), Tschechoslovakei (Böhmerwald, Umg. Prag, Slovaeki), Österreich (Wien, Wienerwald), Ungarn, Siebenbürgen, Kroatien; in den letzteren Ländern ssp. *parallelocollis* Machulka (V.-K. 5).

6. *Stenichnus foveola* Rey (*compediensis* Méquignon). Westareal: Frankreich (Lyon, Compiègne). — Ostareal: Österreich (Wien), Böhmen (Weltus b. Prag), Mähren (Umg. Brünn), Slovaeki (Tatra, Fatra, Kaschau) (V.-K. 6).

7. *Eucninus chrysocomus* Saulcy. Westareal: Südfrankreich (Montpellier, Ostpyrenäen b. Cerbère), Nordspanien (Barcelona); Korsika und Sardinien (?). — Ostareal: Österreich (Mödling und Dt. Altenburg), Ungarn (Fundort mir unbekannt), Tschechoslovakei (Prag, Nikolsburg), Sachsen (Pirna), Mark Brandenburg (Frankfurt a. d. Oder). Die Art wird auch aus dem Kaukasus angegeben, ist also vielleicht noch weiter im Osten (Polen, Südrussland) verbreitet (V.-K. 7).

8. *Scydmaenus Perrisi* Rtt. Ostareal: Von der Balkanhalbinsel (Morea) über Bosnien, Kroatien, Istrien, Krain, Siebenbürgen bis Südpolen, Tschechoslovakei, Österreich (Kärnten und Niederösterreich) bis Ostdeutschland (Schlesien, Mark Brandenburg, Sachsen, Thüringen, Harz, Südostbayern—Umg. München). — Westareal: Frankreich von den Ostpyrenäen und dem Mittelmeergebiet nach Norden bis Fontainebleau, Compiègne, Vierzon, Mühlhausen im Elsass. In Südwestdeutschland (Baden etc.) bisher nicht sicher festgestellt. — Die Art reicht im Südosten bis in die mediterrane Region (Griechenland), aber da sie bisher nicht aus Italien gemeldet ist, kann sie nicht als mediterrane Art angesprochen werden; es ist eine klare Auslöschungszone zwischen Ost- und Westareal vorhanden (V.-K. 8).

*Familie Scarabaeidae:*

9. *Aphodius conjugatus* Panz. Ostareal: Südrussland (Krim), Rumänien, Siebenbürgen (10 Fundorte, nach Petri 1912), Südpolen, Ungarn, Österreich (bisher nur einige alte Angaben aus dem Donau-Gebiet in Nieder- und Ober-Österr.), Südbayern (alte



7. *Euconnus chrysocomus* Sauley.



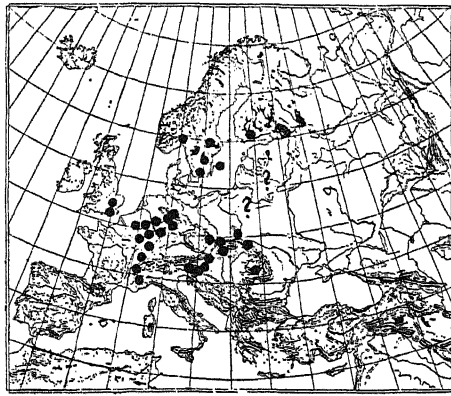
8. *Scydmaenus Perrisi* Rtt.



9. *Aphodius conjugatus* Panz. 10. *Hoplia hungarica* Burm. mit subnuda Rtt. (offene Kreise).



11. *Mycetoma suturale* Panz.



12. *Phloeothrya rufipes* Gyll.

Angaben; 1 altes Ex. aus Ingolstadt; wahrscheinlich heute dort nicht mehr vorhanden). — Westareal: Frankreich in Mitte und Südwesten (Nièvre, Allier, Rhône, Isère, Puy-de-Dôme, Tarn, Gironde-Bordeaux) (V.-K. 9).

10. *Hoplia hungarica* Burm. Westareal: Südfrankreich (Provence, Languedoc bis Toulouse, Albi, Lyon). — Ostareal: Siebenbürgen (Schässburg, Kronstadt, Bucsecs), Ungarn, Österreich (Donaugebiet in Niederösterreich), Slowakei (Pressburg und andere Fundorte), Tschechisch-Schlesien (Teschen a. d. Olsa, Weichsel und Schwarzwasser). — In den Formenkreis der *H. hungarica* gehört auch *H. subnuda* Rtt., die auf Grund der Klauenbildung abgetrennt ist und im Ostareal vielfach an denselben Fundorten wie *hungarica* vorkommt (Slowakei, Österreich), aber auch sehr sporadisch und vereinzelt in Ostdeutschland (Schlesien-Sagan, Mittelelbe-Dessau, Halle, Naumburg) gefunden wurden (V.-K. 10).

#### *Familie Serropalpidae:*

11. *Mycetoma suturale* Panz. Ostareal: Tschechoslowakei (Rainwiese a. d. Elbe vor 1868, Böhmerwald; Mähren, Slowakei), Österreich (Salzburg, Steiermark: alte Meldungen), Ungarn, Banat (Herkulesbad), Kroatien, Istrien. — Westareal: Schweiz (Kt. Waadt), Frankreich (Lyonnais, Puy-de-Dôme, Landes, Basses-Pyrénées). Das typische Exemplar soll aus Göttingen (Südhanover) stammen, was unwahrscheinlich ist; aus Deutschland bisher nicht sicher bekannt geworden. (V.-K. 11).

12. *Phloeothrya rufipes* Gyll. Westareal: Ostfrankreich (vom Alpengebiet bis zum Elsass; Morvan, Bourgogne, Rhône), Südbelgien, Südholland (Limburg), Südost-England (nördl. bis Yorkshire), Westdeutschland vom Mittelrhein (Rheinprovinz, Pfalz, Hessen) bis zum Wesergebirge (Süntel) und Harz. — Ostareal: Österreich (im Ostalpen-Gebiet von Niederöst., Steiermark, Kärnten), Ungarn, Slowakei und Mähren (Karpathen, Beskiden), Polen (Karpathen), Siebenbürgen (Kerzergebirge). Die Art wird in Waldgebieten von Osteuropa (Polen, Russland, Baltikum) weiter, als mir bisher bekannt, verbreitet und von dort zum südlichen Nordeuropa vorgedrungen sein: Südfinnland (Abo), Schweden (Insel Gotland, Västergötland, Schonen), Norwegen (Umg. Oslo) (V.-K. 12).

Diese Beispiele mögen für einen ersten Hinweis genügen. Sie zeigen klar, dass es sich wirklich bei diesen Arten um zwei getrennte Verbreitungsgebiete handelt, deren Zentren (Ausgangs-Mittelpunkte) einerseits im südöstlichen Mitteleuropa (Ungarn, Slowakei, Siebenbürgen — im pannonischen Raum), andererseits im südwestlichen Mitteleuropa (Frankreich-Mitte und Süden) liegen. Diese Diskontinuität kann nur eine Folge der Glazialzeiten sein, die ja auch nach der heutigen allgemeinen Auffassung die Diskontinuität bei den borealpinen und boreomontanen Arten verursacht haben. Es ist anzunehmen, dass diese Arten, die heute eine diskontinuierliche Ost—West-Verbreitung haben, vor den Glazialzeiten im mitteleuropäischen Raum kontinuierlich verbreitet waren, aber durch den Kälte-Einbruch in allen Gebieten, die zwischen den nordischen und alpinen Gletschern lagen, vernichtet wurden; sie konnten nur in den Gebieten, die von den Gletschern weit entfernt waren — Frankreich, Ungarn u. s. w. — weiter existieren oder waren gezwungen, sich dorthin zurückzuziehen. In diesen beiden Refugien haben sie die Glazialzeiten überstanden und von dort aus haben sie nach dem Rückzug des Eises sich wieder mehr oder weniger weit in den mitteleuropäischen Raum verbreiten können.

Es gibt Arten, die *kontinuierlich* im mitteleuropäischen Raum von Russland bis Frankreich verbreitet sind, bei denen wir aber eine *bizentrische* Ausbreitung konsta-



13. *Rhagonycha translucida* Kryn.



14. *Opilo pallidus* Oliv.



15. *Bothrioderes contractus* F.



16. *Elater sinuatus* Germ.



17. *Porthmidius austriacus* Schrank.



18. *Coproporus colchiensis* Kr.

tieren können, weil sie im äussersten Westen und Osten ihres Verbreitungs-Areals eine deutliche *Anhäufung der Fundorte* aufweisen. Als Beispiele solcher kontinuierlicher Ost—West-Verbreitung bringe ich hier die Verbreitungskarten von *Rhagonycha translucida* Kryn., *Opilo pallidus* Oliv. und *Bothrioderes contractus* F. Bei *Rhagonycha translucida* sehen wir, dass sie sowohl nördlich wie südlich der Alpen kontinuierlich verbreitet ist; in den mittel- und westdeutschen Gebirgen kommt sie nur sehr zerstreut vor und gilt allenthalben als Seltenheit, während sie aus dem Osten (Karpathen, Sudeten) als nicht selten oder als häufig gemeldet wird; in Frankreich dringt diese sonst montane Art auch in die nördliche Ebene vor und ist sogar in früher postglazialer Zeit, als die Landbrücke noch bestand, nach Grossbritannien transgrediert. Die beiden anderen Arten, *Opilo pallidus* und *Bothrioderes contractus*, haben nur über den Südhang der Alpen, in Norditalien, eine Verbindung zwischen dem Ost- und West-Areal, während sie nördlich der Alpen in weiten Strecken von Mittel- und Westdeutschland fehlen (V.-K. 13, 14, 15).

Die Auslöschungszone zwischen den diskontinuierlich in Ost- und West-Europa verbreiteten Arten muss vor allen Dingen den *Südhang der Alpen* und mehr oder weniger ausgedehnte Gebiete nördlich der Alpen umfassen. Es kann sein, dass eine Art vom Osten her bis in die Ostalpen (Steiermark, Kärnten, Krain, Südtirol) vorkommt und auch in den Westalpen (Piemont, Ligurische Alpen, Meeralpen) wieder auftritt, dann ist eine klare Diskontinuität vorhanden, wenn die Art weiter nach Frankreich hinein verbreitet ist. Ebenso kann eine Art nördlich der Alpen bis in die deutschen Mittelgebirge in Sachsen und Thüringen verbreitet sein; wenn sie aber im Rheingebiet fehlt und in Frankreich wieder auftritt, ist sie diskontinuierlich verbreitet.

Es ist allerdings darauf zu achten, dass heute manche rein *südosteuropäische* Arten, die man auch — je nach ihrer Ausbreitung im Südosten — pontische oder pannonische Arten nennt, im mitteleuropäischen Raum nur mehr eine sehr zerstreute Verbreitung haben, sodass man in manchen Fällen eine Diskontinuität annehmen könnte. Aus den vielen Beispielen greife ich die beiden Elateriden *Porthmidius austriacus* Schrank und *Elater sinuatus* Germ. heraus. Die letztere Art kommt kontinuierlich von Südost-europa bis zur Slowakei und den östlichen Ländern von Österreich vor, ist aber auch im Rheingebiet (Hessen, Nordbaden), Schweiz (Schaffhausen, Zürich) und Piemont (Mt. Cénis) gefunden worden (Verbreitungskarte 16). *Porthmidius austriacus* Sch. dringt aus Südosteuropa bis zu den xerothermen Hängen an der Oder, bis zum Harz und Kyffhäuser vor und hat noch zerstreute Fundorte im Rheingebiet (Nahe, Pfalz), Südbelgien (Charleroi), Ost-Frankreich (Oise, Marne, Savoyen, Basses-Alpes), West-Schweiz (Berner Jura b. Biel); vergl. Verbr.-Karte Nr. 17. Wenn diese westlichen Fundorte heute auch isoliert erscheinen, so liegen sie doch auf den Verbreitungswegen der südosteuropäischen (pontischen) Arten, über deren Verlauf wir durch die Standorte der Steppenheide-Pflanzen gut orientiert sind. Ob diese westlichen Fundorte als Relikte einer postglazialen Wärmeperiode oder als rezente Zuwanderer anzusprechen sind, ist schwer zu entscheiden; auf alle Fälle aber handelt es sich um rein südosteuropäische Arten, die mit dem hier behandelten Problem einer bizentrischen Ost—West-Verbreitung nichts zu tun haben.

Auch *mediterrane* Arten, die manchmal „circumalpin“ weit nach Mitteleuropa vordringen, einerseits bis nach Elsass und Süddeutschland, andererseits bis nach Niederösterreich, Böhmen-Mähren und Südostdeutschland, können eine bizentrische Diskontinuität vortäuschen, besonders wenn das mediterrane Vorkommen bisher noch nicht



19. *Carabus monilis* F. ssp. *monilis* F. (schwarze Kreise); ssp. *Scheidleri* Panz. u. ssp. *excellens* F. (offene Kreise).



20. *Trox Perrisi* Fairm. (schwarze Kreise). *Trox Eversmanni* Kryn. (weisse Kreise).

recht bekannt ist. Ich bringe hier die Verbreitungskarte des Staphyliniden *Coproporus colchicus* Kr. (Nr. 18), der ein merkwürdig konzentriertes Vorkommen in Südfrankreich und in der Slowakei hat, der aber wohl im mediterranen Raum, besonders im Südosten, viel weiter verbreitet ist, als bis heute bekannt ist. —

Die Zersplitterung des zusammenhängenden Verbreitungsgebietes durch die Eiszeiten und die Isolierung in weit entfernte Gebiete führte selbstverständlich auch zur Bildung von vikariierenden Arten und Rassen. Ein markantes Beispiel bildet der Formenkreis des *Carabus monilis* F. Die Nominatrasse (ssp. *monilis*) hat ihr Verbreitungsgebiet in Westeuropa, ssp. *Scheidleri* mit der sehr nahestehenden ssp. *excellens* in Südost- und Osteuropa. Da ssp. *monilis* vom Westen her nur wenig über das Rheingebiet vordringt und ssp. *Scheidleri* in Deutschland nur in Südost-Bayern vorkommt, während in Nord-Italien die Art gänzlich fehlt, besteht heute zwischen den beiden Formen noch ein klare Auslöschungszone; vergl. Verbreitungskarte Nr. 19 und die genauen Verbreitungsangaben im 1. Band meiner „Faunistik“ (Wien 1941, 57—58). — Ein anderes Beispiel: *Ptilium Schuleri* Gglb. war bisher nur aus Mähren und Slowakei bekannt; der französische Koleopterologe Normand beschrieb 1938 (Rev. franç. d'Ent. V., 32) ssp. *massanae* aus Südwest-Frankreich (Collioure). — Von vikariierenden Arten nenne ich *Trox Perrisi* Fairm. (Westeuropa) und *Trox Eversmanni* Kryn. (Osteuropa); ihr heutiges Verbreitungsgebiet überschneidet sich in Mittel-Deutschland (Sachsen, Thüringen, Mark Brandenburg); vergl. Verbr.-Karte Nr. 20. Andere vikariierende Arten sind z. B. *Prionychus melanarius* Germ. (Ost), und *P. Fairmairei* Reiche (West) mit getrennten Arealen; *Melandrya caraboides* L. (West) und *M. dubia* Schall. (Ost), *Blaps mucronata* Latr. (West) und *B. mortisaga* L. (Ost), bei denen die Areale sich weitgehend überschneiden, aber nach Westen und Osten immer deutlicher ihre getrennten Entstehungsgebiete aufweisen.

Die diskontinuierliche Ost—West-Verbreitung, die wir hier für die Koleopteren kennen gelernt haben, hat natürlich auch in den anderen Tierordnungen ihre analogen Fälle. Bekannte Beispiele liefert besonders die Vogelwelt mit Nachtigall und Sprosser (*Erithacus lucinia* und *E. philomela*), mit Rabenkrähe und Nebelkrähe (*Corvus corone* und *C. cornix*). Auf einen Fall aus den Säugetieren weist Rich. Hesse in seiner

„Tiergeographie“ (Jena 1924, S. 104) hin: „Die in den nordspanischen Gebirgen lebende Bisamspitzmaus (*Myagale pyrenaica*) ist von dem übrigen Verbreitungsgebiet der Gattung in den südrussischen Steppen durch eine weite Strecke getrennt; doch findet man im Zwischengebiet fossile Reste der Gattung in diluvialen Ablagerungen in Frankreich, Belgien, England und Deutschland; jetzt aber ist *Myagale* hier ausgestorben, wahrscheinlich infolge der Veränderungen des Klimas und der Vegetationsverhältnisse“.

Zum Schlusse will ich noch kurz auf einige weitere Käfer-Arten hinweisen, die nach den heutigen Angaben eine diskontinuierliche Ost—West-Verbreitung aufweisen: *Catops nitidicollis* Kr., *Colon armipes* Kr., *Liodes lucens* Fairm., *Liodes Brandisi* Holdh. (aus Süd-Frankreich gemeldet: Rev. franç. d'Ent. 9, 1942, 75: teste Portevin), *Cyrtoplastus* (*Amphicyllis*) *seriepunctatus* Bris., *Plegaderus discisus* Er., *Cantharis annularis* Mén., *Cerapheles terminatus* Mén., *Trichocele fulvohirta* Bris., *Agrilus Guerini* Lac. (das Ostareal ist bisher noch wenig bekannt: Mark Brandenburg, Polen, Krim; auch aus Mittelschweden gemeldet), *Hypnoidus flavipes* Aubé, *Elater ruficeps* Muls., *Dirrhagus Sahlbergi* Mannh., *Attagenus pantherinus* Ahr., *Pityophagus laevior* Ab., *Cyllodes ater* Er. (paläarktisch verbreitet, aber in Mitteleuropa anscheinend diskontinuierlich), *Laemophloeus castaneus* Er., *Triplax collaris* Schall., *Cerylon evanescens* Rtt., *Novius cruentatus* Muls. (zerstreute Angaben aus Südeuropa vielleicht importiert), *Ennearthron Wagai* Wank., *Apalus* (*Sternoria*) *analisis* Schaum, *Aphodius Zenkeri* Germ. — Die Phytophagen (*Cerambycidae* etc.) habe ich noch nicht bearbeitet.

Die vorstehenden Arten kommen alle auch für die deutsche und österreichische Fauna in Betracht und sind mir deshalb besonders aufgefallen. Es gibt aber auch eine Reihe von Arten, die bisher nur aus Frankreich und Osteuropa gemeldet sind, also die Diskontinuität besonders krass zeigen, von denen mir bisher nur wenige zufällig bekannt geworden sind, wie *Onthophagus truchmenus* Kol., der nach Paulian 1941 (Faune de France 38, p. 76) an zwei Stellen in Frankreich und in Südrussland, Kleinasien etc. gefunden wurde; *Astatopteryx laticollis* Perris (Fam. *Ptiliidae*): Südfrankreich, Korsika—Ungarn, Slowakei; *Xyletinus sanguineocinctus* Fairm.: Südfrankreich—Südrussland, Kaukasus. Sicherlich kann diese Liste noch vermehrt werden.

Bei allen diesen Arten handelt es sich um seltene oder sehr seltene Käfer, sodass man mir entgegenhalten kann, dass ihr Verbreitungsgebiet bisher noch nicht genügend bekannt ist, dass aber durch weitere Forschungen neue Fundorte entdeckt werden, und so schliesslich ein kontinuierliches Verbreitungsbild herauskommen wird. Da ich selbst die Kontinuität in der Verbreitung als die natürliche Grundlage der ganzen Faunistik erkenne und diskontinuierliche Verbreitung für einen Ausnahme-Fall ansehe, so stand ich im Anfang meiner Studien einer diskontinuierlichen Ost—West-Verbreitung selbst sehr skeptisch gegenüber. Aber es traten immer mehr derartige Arten auf und darunter auch solche, die in ihrem Ost- oder in ihrem Westareal gerade nicht zu den besonderen Seltenheiten gehören. Wenn diese Arten bisher nicht im Rheinland oder in Thüringen, wo seit über 100 Jahren intensive koleopterologische Forschung betrieben wurde, gefunden wurden und auch in Nord-Italien konstant fehlen, dann darf doch wohl von dem besonderen Verbreitungs-Modus der diskontinuierlichen Ost—West-Verbreitung gesprochen werden, wenn vielleicht auch die eine oder andere der angeführten Arten sich im Laufe weiterer Forschungen als nicht hierhin gehörig erweisen wird. Bei vielen der angeführten Arten, besonders bei denen, die nur schwierig zu determinieren sind, muss allerdings unbedingt durch Vergleich und anatomische Untersuchung der Belege die Identität der östlichen und westlichen Stücke bewiesen werden. Das konnte ich leider bisher wegen der schwierigen Zeitverhältnisse nicht durchführen.



Mit dieser Arbeit wollte ich nur einen ersten Hinweis auf das Problem der diskontinuierlichen Ost—West-Verbreitung geben, ein Problem, dessen restlose Klärung nur durch internationale Zusammenarbeit gelingen kann. Vielleicht dass der eine oder andere der zoogeographisch interessierten Koleopterologen der einzelnen europäischen Länder den von mir angeführten und ähnlich verbreiteten Arten seine Aufmerksamkeit schenkt. Ich stehe gern mit den genauen Fundangaben aus Deutschland und Österreich zur Verfügung.

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## PHÄNOLOGISCHE BEOBACHTUNGEN AN ALPINEN DIPTEREN

Von Fred Keiser

Während meiner vieljährigen dipterologischen Untersuchungen im Schweizerischen Nationalpark<sup>1</sup>, deren Ziel es in erster Linie war, eine möglichst vollständige Bestandsaufnahme durchzuführen, machte ich immer wieder die Beobachtung, wie quantitativ und auch qualitativ verschieden die Ausbeute einer Fundstelle ausfallen kann, obgleich die Witterung durch keine störenden Momente beeinflusst worden war, sondern sich ganz normal verhalten hatte. Die Erfahrung lehrte bald, dass die Morgenstunden zwischen 8 und 11 Uhr, je nach Höhenlage und Exposition der Lokalität, für das Einbringen einer reichhaltigen und grossen Beute am ergiebigsten waren, während in den ersten Nachmittagsstunden der gleich Ort als fast steril sich erweisen konnte. Andererseits lieferte eine als spärlich notierte Fundstelle zu anderer Tageszeit eventuell ein befriedigendes Fangergebnis. Solche Feststellungen werden jedem Feldentomologen nicht unbekannt und auch dem ökologisch arbeitenden Forscher dürften sie nicht entgangen sein. Jedenfalls sollten sie für die Charakterisierung der untersuchten Biotope mit in Berücksichtigung gezogen werden.

Die eben erwähnten Beobachtungen veranlassten mich, einmal der Frage näher zu treten und zu prüfen, welchen Veränderungen die Dipterenfauna einer in sich geschlossenen Lokalität im Verlaufe eines ganzen Tages unterworfen ist und in welcher Richtung sie auf die Änderungen der klimatischen Faktoren reagiert.

Zu diesem Zwecke wählte ich im zentralen Teil des Nationalparks 3 Stationen in annähernd gleicher Höhenlage und ähnlicher Exposition. Alle drei liegen im oberen Gürtel der regio subalpina (2050—2150 m), sind kurzgrasige, nicht sonderlich reich beblumte Weiden und zeigen in ihrem Habitus keine wesentlichen Differenzen. Auf diesen Weiden steckte ich meine Untersuchungsflächen in der Grösse von 5×5 m ab und stellte mir die Aufgabe, in Stundenfängen von Sonnenaufgang bis Sonnenuntergang möglichst alle einfliegenden Dipteren einzusammeln, um auf diese Weise ein Bild von der *Tagessukzession* zu erhalten. Um die wahrscheinliche Wirkung der *Klimafaktoren* auf die Fauna in Bezug auf ihre Zusammensetzung und numerische Grösse zu ermitteln, sind der Gang der *Temperatur* in 0, 5, 25, 50, 100 und 150 cm über Boden, der *relativen Feuchtigkeit* in 5 und 150 cm über Boden und der *Windgeschwindigkeit* durch halbstündliche Ablesungen an den Instrumenten verfolgt worden. Neben diesen Klimatelementen kommt in den Alpen der *Strahlung* eine ganz besondere Bedeutung zu, wobei nicht allein die *direkte Sonnenstrahlung*, sondern auch die *diffuse Himmelstrahlung* und die *Strahlungsreflexion* von Erdboden, Steinen und Pflanzen auf die über der Erde lebenden Insekten einwirken. Deshalb hielt ich es für erforderlich, auch der *Globalstrahlung*, d. h. der Gesamtwirkung der Strahlung auf die Untersuchungsfläche, meine Aufmerksamkeit zu schenken und sie in den Bereich der Beobachtungen über den Klimaablauf des Tages miteinzubeziehen.

Im folgenden seien aus dem zusammengebrachten Material nur wenige Resultate herausgegriffen und an Hand einiger graphischer Darstellungen, die sich nur auf eine Station beziehen, die ermittelten Befunde vorgelegt.

<sup>1</sup> F. Keiser, Die Fliegen des Schweizerischen Nationalparks und seiner Umgebung. Pars I: Brachycera Orthorhapha. Erg. wiss. Unters. des Schweiz. Nationalparks, Bd. II, 1947.

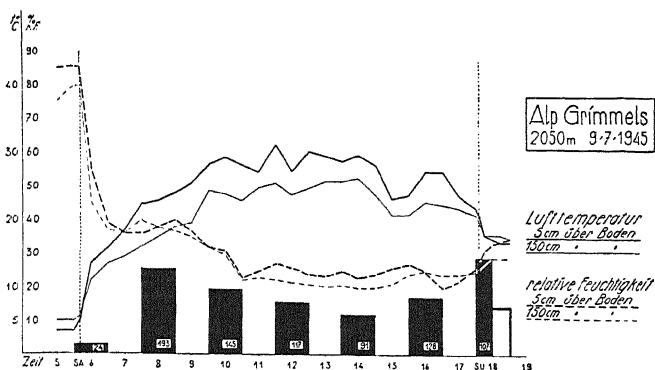


Fig. 1.

Die erste Darstellung gibt die Verhältnisse eines Normaltages mit nur wenig gestörtem Temperaturverlauf wieder; die Einbrüche in den Kurven sind bedingt durch auffrischende, aber nur während kurzer Zeit anhaltende Winde, die jedoch sogleich ein Absinken der Temperatur zur Folge hatten. Bald nach Sonnenaufgang und wieder nach Sonnenuntergang beobachtet man eine Ueberschneidung der Temperaturkurven; die anfänglich tiefere Temperatur in Bodennähe nimmt im Verlaufe des Tages höhere Werte an als die Temperatur höher gelegener Luftschichten, um dann abends erneut unter diese abzusinken. Die Temperatur bedingt die relative Luftfeuchtigkeit: Temperaturanstieg hat Abnahme der relativen Feuchtigkeit im Gefolge und umgekehrt.

Gesammelt wurde auf der abgesteckten Beobachtungsfläche von 25 m<sup>2</sup> von Sonnenaufgang bis nach Sonnenuntergang. Vor Sonnenaufgang, d. h. bevor die Untersuchungsfläche von den Sonnenstrahlen berührt wird, war höchst selten eine Fliege zu sehen; sie hielten sich alle in ihren Nachtquartieren (im Grasfilz und unter Blättern) verborgen, bis eine gewisse Erwärmung eingetreten war. Abend dauerte das Leben noch kurze Zeit über den Sonnenuntergang an, um dann mit dem normalerweise raschen Absinken der Temperatur fast schlagartig zu erlöschen.

Das Verhalten der Population während des Tages ist aus der graphischen Darstellung der Stundenfänge ersichtlich. Die 1. Stunde mit der tiefen Morgentemperatur (3,5—16° C) ergab nur eine kleine Ausbeute. Die 2. Stunde (22,5—25° C) lieferte das Maximum. Mit zunehmender Temperatur bis über 30° C stellten sich in den folgenden Stunden Verminderungen der Fangergebnisse ein bis zu einem Minimum um 14 Uhr. Im Verlaufe des Nachmittags folgte bei abnehmender Temperatur ein erneutes Ansteigen und in der letzten Stunde, zur Zeit des Sonnenuntergangs, wieder ein Abfallen, wobei zu beachten ist, dass das Material dieser letzten Stunde keinem effektiven Stundenfang entspricht.

Durch die grösseren und kleineren Einbrüche in den Temperatur- und Feuchtigkeitskurven ist der andersgeartete Tag ohne weiteres gekennzeichnet. Sie waren verursacht worden durch heftigere und anhaltende Winde, besonders aber infolge Ueberschattung der Fläche durch Bewölkung von wechselnder Dauer. Schon die frühen Morgenstunden zeichneten sich durch eine drückende Schwüle aus, was im hohen Fangresultat der 1. Stunde zum Ausdruck kommt. Für sein Zustandekommen scheint mir noch von Bedeutung zu sein, dass ein eigentlicher Sonnenaufgang nicht eintrat, da die Sonne

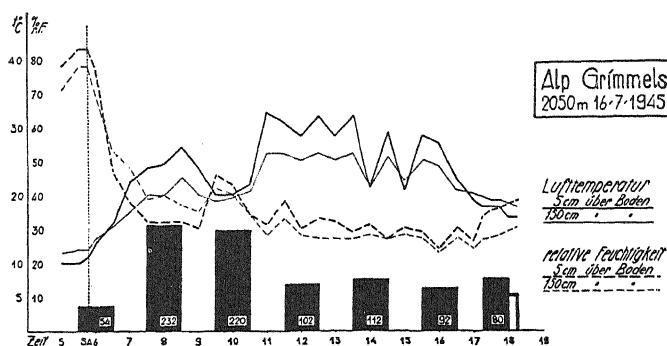


Fig. 2.

durch eine dünne Wolkenschicht verdeckt wurde und nur ein fahles Licht verbreitete. Nach Auflösung der Bewölkung und Anstieg der Temperatur brachte die 2. Fangstunde das erwartete Maximum, dem nun aber in der Folgezeit nicht eine Reduktion der Ausbeute folgte, sondern eine solche gleichen Ausmasses. Andauernde Ueberschattung der Station, verursacht durch eine dichte Wolkenbank vor der Sonne, hatte einen empfindlichen Temperatursturz nach sich gezogen, der die Dipterenpopulation in gleicher numerischer Stärke erhielt. Gegen 11 Uhr begann die Bewölkung zu schwinden, die Temperatur stieg sofort sprunghaft an und zog gleichzeitig einen Frequenzabfall nach sich. Erneute Bewölkung von kurzer Dauer wechselte hierauf mit klarem Himmel; die Temperaturkurve weist infolgedessen weitere Einbrüche auf und zeigt im allgemeinen fallende Tendenz. Das für die 2. Nachmittagsstunde charakteristische Minimum stellte sich nicht ein, vielmehr blieb die Population in ihrer Dichte bestehen. Mit einem gegenüber dem 1. Beobachtungstag vorzeitigen Absinken der Temperatur am späteren Nachmittag (17 Uhr: am 9. 7.: 24° C, am 16. 7.: 19° C) fand nun auch eine sukzessive Abnahme der Fliegenfauna statt.

Nach den Beobachtungen und Befunden im Jahre 1945 hat sich herausgestellt, dass zwischen dem Ablauf der Temperatur und der Dichte der Dipterenpopulation einer Fundstelle eine Korrelation besteht. Die Temperaturverhältnisse selbst sind beeinflusst von zwei weiteren Faktoren, nämlich von der gesamten Strahlung und den Luftströmungen. Deshalb suchte ich im folgenden Jahre auch diese beiden Komponenten durch direkte Messung zu erfassen. Die ermittelten Ergebnisse sind in den beiden folgenden Diagrammen veranschaulicht.

Nach anfänglich gleichmäßigem Anstieg der Strahlungskurve erfolgt bald nach Sonnenaufgang, hervorgerufen durch Wolkenbildung im Osten, ein Abfall, der nach Auflösung der Wolkenschicht sofort wieder in einen rapiden Anstieg übergeht. Der Einbruch in der Temperaturkurve und eine Störung in der Kurve der relativen Feuchtigkeit erfolgen synchron. Dünne Wolkenschleier vor der Sonne liessen die Strahlung nie die Intensität erreichen, wie sie an anderen Tagen gemessen werden konnte (105'000 Lux gegen 130'000 Lux um 13 Uhr). Das Maximum zeichnete sich jedoch um die Mittagszeit ab. Nach seinem Ueberschreiten stellte sich kurz vor 15 Uhr eine intensive Strahlungsabnahme ein, die fast während einer Stunde anhielt und zu einer Erniedrigung der Temperatur führte. Nach erneuter Aufhellung des Himmels, verbunden mit gleichzeitigem Wärmeanstieg, folgte das gleichförmige Abfallen beider Kurven gegen

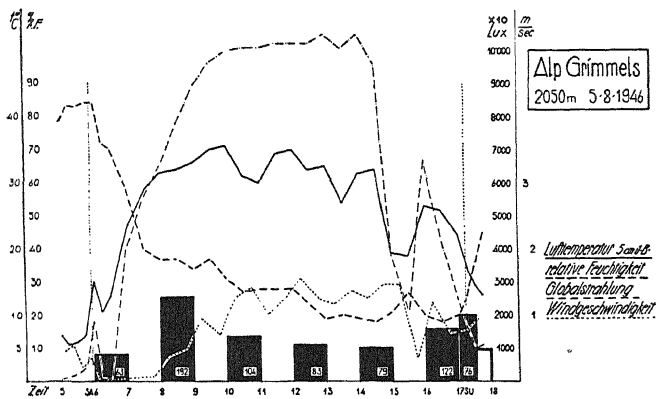


Fig. 3.

Sonnenuntergang hin. Die Schwankungen im Temperaturverlauf während des Morgens erwiesen sich aber bei der Konstanz der Globalstrahlung als Ausdruck wechselnder Luftströmungen, die zwar nicht anhaltend, sondern nur stossweise wirkten. Die Linienführung gibt deshalb nicht die wirklichen Temperaturverhältnisse wieder, da die tieferen Temperaturen, zufällig auf die Ablesungszeit fallend, jeweiligen nur über kurze Zeit anhielten und nicht von längerer Dauer waren; sie unterbrachen die viel längeren Perioden grösserer Wärme. Unter Berücksichtigung dieser ergänzenden Erklärung erkennt man, dass die Dipterenpropulation sich wie am 1. Normaltag (9. 7. 1945) verhält, mit ausgesprochenem Maximum am Morgen zwischen 8 und 9 Uhr und charakteristischem Minimum am frühen Nachmittag zur Zeit des Strahlungsmaximums. Die Auswirkung des Temperaturfalls zwischen 15 und 16 Uhr, bedingt durch eine beträchtliche Senkung der Strahlungsintensität, konnte, da gerade in einer Zwischenzeit liegend, nicht erfasst werden.

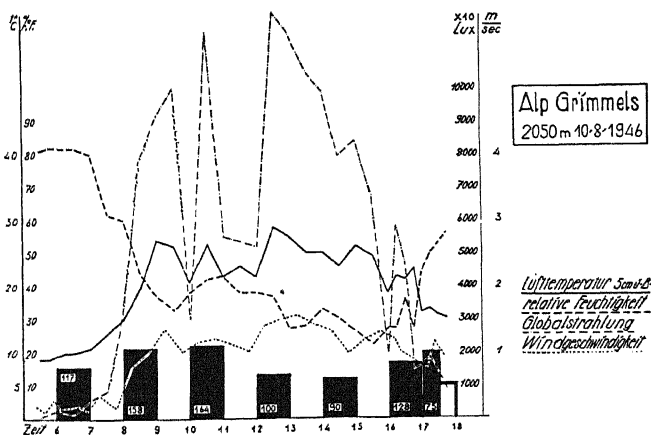


Fig. 4.

Der 4. Beobachtungstag begann bei bedecktem Himmel (Strahlungskurve!) mit relativ hoher Morgentemperatur; der 1. Stundenfang fiel dementsprechend sehr gross aus. Langsame Auflösung der Bewölkung bewirkte Zunahme von Strahlungsintensität und Temperatur, die aber des herrschenden Windes wegen unter der zu erwartenden Höhe blieb. Die Frequenz in der Population hat wohl zugenommen, aber nur in bescheidenem Masse. Erneute Wolkenbildung, von Aufhellungen wechselnder Dauer unterbrochen, waren für den ganzen übrigen Tag bezeichnend. Eine nur kurze Zeit andauernde Aufklärung in der Mitte der 3. Fangstunde brachte keinen Rückgang in der Population; diese hielt sich vielmehr auf demselben Niveau. Der Nachmittag ist beim ständigen Wechsel der klimatischen Faktoren, der aber im Kurvenverlauf nicht genügend zum Ausdruck kommt, durch seine Ausgeglichenheit ausgezeichnet; das nachmittägliche Minimum ist kaum angedeutet. Die beiden letzten Fangzeiten ergaben bei ständig sich änderndem Witterungscharakter zunächst den üblichen Anstieg der Ausbeute mit darauffolgender Abnahme.

Es wäre nun natürlich von Interesse, auf das Verhalten der Fliegen im allgemeinen während eines Tages näher einzutreten und ihre Reaktion auf die Änderungen der klimatischen Faktoren zu beleuchten. Leider muss ich an dieser Stelle davon Abstand nehmen, wie auch von der Diskussion der Befunde über das Verhalten der einzelnen Arten selbst. Ich beschränkte mich darauf, das Verhalten der ganzen Population zu zeigen und dieses in Beziehung zum Lokalklima zu setzen. Wenn auch meiner Mitteilung in einigen Punkten der Charakter der Voruntersuchung anhaftet, wobei verschiedene Fragen einer näheren Präzisierung noch bedürfen und weitere Probleme abzuklären sein werden, so glaube ich doch nicht nur die eingangs geäußerte Beobachtung zahlenmässig erhärtet, sondern auch gezeigt zu haben, dass eine Korrelation besteht zwischen der *Fliegenpopulation einer Lokalität* einerseits und der *herrschenden Witterung* andererseits. Unter den Klimafaktoren möchte ich der *Strahlung* das Primat einräumen; sie bedingt die Temperaturverhältnisse, die nun ihrerseits wieder bei den auftretenden Erwärmungsdifferenzen zwischen Tal und Berggipfel, bewaldetem Hang und nackter Schuttfur die lokalen Luftströmungen verursachen und die relative Luftfeuchtigkeit bestimmen.

Die für die Alp Grimmel erhaltenen Ergebnisse stellen etwa nicht einen Spezialfall dar, sondern decken sich mit den Befunden von den beiden anderen Stationen vollständig und bringen die exakte Bestätigung der in den Vorjahren gemachten Beobachtungen. Die belebende Wirkung der Sonnenwärme am Vormittag lässt die Dipteren in Menge ausschwärmen und die Population zu einem Maximum sich entfalten. Bis in die ersten Nachmittagsstunden steigt die Globalstrahlung, und mit ihr auch die Temperatur, in einem solchen Masse an, dass die Fliegen gezwungen werden, sich ihrer Wirkung durch Aufsuchen von Verstecken oder Aufsteigen in höhere Luftschichten zu entziehen. Erst die späteren Nachmittagsstunden bringen wieder Strahlungs- und Temperaturverhältnisse, welche ihnen das Verlassen der Schutzplätze gestatten und vor dem Beziehen der Uebernachtungsorte ein erneutes, wenn auch nur kurzes Ausschwärmen ermöglichen.

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## HOST-FINDING AND HOST-ALTERNATION IN APHIDES

By J. S. Kennedy

Abandonment of old host-plants and colonisation of new ones is a well-established feature of aphid phenology. It is commonly described as migration from one host to another. Such a description already goes beyond phenology into behaviour, for it carries the implication, widely accepted among workers in this field, that the insects are attracted to their new host, sensing it and directing themselves toward it from a distance. But no satisfactory evidence of such behaviour has been brought forward. When autumn migrants gather in masses on their appropriate winter hosts, however few and far between those hosts may be, it does at first sight appear that the insects are being attracted to these plants. But we have, after all, no record of how many others fail to find their right host.

The present work began with a search for evidence that the black bean aphid, *Aphis fabae* Scop. and the peach-potato aphid, *Myzus persicae* Sulz. could distinguish their specific hosts from other plants before alighting on them. A variety of observations and experiments, in the field and in the laboratory, gave consistently negative results. In the laboratory, for example, winged *A. fabae* failed to move preferentially up a pronounced gradient of bean (*Vicia faba*) odour as compared with one of tomato odour. When such aphids were taken into the field and released in a small portable wind-tunnel or into the free air, their behaviour in air blowing directly off a bean field was indistinguishable from their behaviour down-wind of a wheat field. A simpler and more conclusive method of testing for attraction was employed during the mass migration of *Myzus persicae* in the autumn of 1947. All the aphids seen in the act of alighting on a small peach tree (*Prunus persica*) and on an adjacent small spindle tree (*Euonymus europaeus*) were collected concurrently and later identified. The proportion of *M. persicae* among the aphids landing on spindle was as high as on peach. Moreover *M. persicae* constituted a high proportion of the aphids caught in the act of taking off again from peach: only a minority of the *persicae* that landed on peach remained on it for as long as 24 hours. The segregation of the different aphid species to their proper hosts progressed slowly, and was not quite complete even at egg-laying.

Although random as between "right" and "wrong" hosts, alightments were not passive. Flying aphids are not "combed out" of the air by plants as they are by sticky traps. Alightments took place only when the air was still enough for the insects to be in control of their own movements, and they clearly directed themselves to their landing-place at least over the last few centimetres. Since *M. persicae* made such directed alightments equally on peach and spindle it seems most improbable that the smell of the host directs aphids to it, although smell possibly plays its part after alightment. The alighting response appeared to be a non-specific *visual* one, evoked by objects looming up along the path of the flying insect.

The behaviour of migrants before they have alighted, although not much affecting their ultimate distribution as between different plant species, can play a decisive part in determining their distribution among like plants, as on a crop. This latter problem formed the background of further field observations on the behaviour of flying aphids.

It was found that flying ceased near the ground when the light failed at dusk even when the air remained warm and still enough for it. And the amount of low-level flight activity was very closely governed by wind. Aphids refuse to take off in winds exceeding their own low flight speed (30—60 cm./sec.) and the number to be seen in flight at a given point rises in lulls and falls in gusts in a strikingly sensitive way. Thus active, visually-directed alightment on upstanding objects is likely to be very much concerned in the incidence of migrants on crop-plants, because the necessary conditions for it, daylight and little wind, are also the conditions under which masses of aphids fly freely close to the ground.

In winds approaching their own air speed aphids flying close to the ground direct themselves into the wind and make headway over the ground in that direction. But the wind is extremely variable in speed even when conditions are optimal for mass low flying. Any progress made against the wind in calmer spells is repeatedly wiped out during bouts of stronger wind when the flyers are not only carried down-wind but may also turn round and fly in that direction. Consequently, although low flyers spend much of their time heading into wind, their resultant displacement across the ground will be down-wind. Long traverses across open ground leading to the infestation of new host-crops, must be carried out on the wind, probably in a series of intermittent surging movements. But the tendency to fly up-wind has one important result, which is to concentrate flyers in more sheltered places where they can hold their own against the gentler wind, take off and make local flights and alightments, when they cannot do so in more exposed places.

Putting these observations together, a paradoxical situation emerges. The more air movement past a plant, the more aphids will be delivered into its immediate vicinity. So the plants most exposed to the free flow of the air will be the ones encountered by the most aphids arriving from a distance. Yet, the less air movement past a plant, the more of the aphids which come into its vicinity can stay there, fly about locally and alight upon it. Aphid supply being equal, the more sheltered plant will collect more aphids than the exposed one.

These ideas have been used in attempts to interpret the patterns of *A. fabae* infestation which were studied on crops of beans and sugar beet. There seem to be at least two types of the so-called "edge-effect" on field crops: a concentration of infested plants along a naked crop edge, and a narrower concentration along a crop edge sheltered by a hedge. These two situations are very different aerodynamically, but, bearing in mind the contradictory requirements of plants as aphid-collectors, one would in fact expect edge-effects to be created in two quite different ways, according to the presence or absence of a hedge. A heavy incidence of aphids would be expected on host plants which are themselves exposed to the free flow of the air. Aphids delivered on surges of air would alight, in calmer intervals, most heavily on the first-encountered edging rows which stand up in the path of low-flying insects. Plants further in from the edge would collect fewer aphids because they are screened by the outer plants and so receive a diminishing supply of fresh, aphid-charged air. Plants sheltered by a hedge are also cut off from access to the free, aphid-delivering air and those a few metres from the hedge remain cleaner than plants at that distance from the naked crop edge. Yet the best-sheltered plants of all, those immediately adjacent to the hedge, become densely infested. This is attributable to their proximity to the hedge itself which does stand up prominently in the free-moving, aphid-bearing air. Aphids alight on it in large numbers so that it becomes a temporary local source of aphid supply, and it



also provides a calm air-space in which these aphids can take off, fly about and alight on host plants at times when aphids flying in the open are simply swept away.

The distribution of aphids amongst similar plants, as in a crop, is of considerable practical interest especially in connection with the spread of virus diseases. But the distribution of aphids among dissimilar plants raises the central problem of aphid biology: host preference and host specificity. This problem is being approached indirectly, through the problem of host alternation, again using mainly *A. fabae*. It is often assumed that the abandonment of the winter host for the summer hosts in the spring, and the reverse shift in the autumn, represent simply a change in the aphids themselves. The winged forms produced at different seasons differ somewhat from one another anatomically and sometimes even physiologically (in the type of young they produce, viviparous or oviparous). Those are grounds for supposing that their plant-preferences may also differ, spring and summer migrants having an inherent preference for summer hosts and autumn migrants for winter hosts.

The present work has been done with a different hypothesis in mind: that host-alternation reflects, in the last analysis, seasonal changes in the relative suitability of the winter and summer host-plants. One form of *A. fabae*, the summer winged form which can be produced in the greenhouse all the year round, has therefore been used for most of the experiments. Two convenient types of leaf-cage were devised: one type to confine aphids on a single leaf, primarily for the assessment of relative reproduction-rate; and the other type to confine aphids with access to two dissimilar leaves side by side, for the assessment of settling preferences. Both types of cage can be quickly attached to growing plants. Experiments with these cages have been supplemented by observations on the pattern of infestation among the leaves on a whole plant or shoot. The summer winged forms of *A. fabae* are not ordinarily found on the winter host, the spindle tree, but only on summer hosts such as beans and sugar beet. Nevertheless it has been found both outdoors and in the greenhouse that these aphids will take readily to spindle and even prefer it to sugar beet provided the spindle leaves offered are in an appropriate condition. What exactly constitutes an appropriate condition is not yet clear, for the acceptability of leaves to the aphids cannot always be correlated with the externally-visible characters of the leaves. This is especially so with mature leaves. Here we enter the domain of the plant physiologist and bio-chemist, and one hoped-for result of this work is to formulate more definite questions to put to such specialists than has been possible so far.

However, it has been found, broadly speaking, that young, growing leaves, and also older, senescent leaves are more acceptable to the aphids than mature, fully-functional leaves of the same plant. These relations have been found with both spindle and sugar beet. Now the growth habit of sugar beet is such that acceptable young and older leaves are commonly both present on the same plant (particularly during its vigorous vegetative and early flowering phases in the summer) together with less acceptable parts such as mature or very old leaves, seeding flower shoots, etc. The range of leaf types on spindle, on the other hand, is on the whole less wide at any one time. The majority of leaves tend to be either young (in the spring) or mature (in the summer) or senescent (in the autumn).

These facts form the basis of the hypothesis of natural host alternation. The work is still in progress and the hypothesis has still to be confirmed, but it may be restated as follows. Whatever other seasonal changes, in the aphids themselves or in their relations with their natural enemies, may be involved in host alternation, changes in

the relative suitability of the winter and summer host-plants play a fundamental role. In the early spring the aphids are found only on the woody, perennial winter hosts because they have hatched from eggs laid there and find the plant suitable while it is actively growing. The summer hosts, annual plants, are also actively growing at this time but the aphids have no reason to leave the winter host. Later, when the growth of the woody plant slows down, the aphids, taking wing, find the summer hosts still actively growing and so more acceptable, and colonise them. In the autumn the woody plant leaves start senescing *en masse* while the annual plant leaves either have disappeared or are becoming "dormant". Flying aphids now find their "primary host", the woody plant, more acceptable and so effect their "return migration".

(Reply to Dr Hille Ris Lambers, in discussion.)

As to the first question, why mass flights are most common in the evening, there appear to be at least two reasons for this. First, during the day, in bright sun and little wind, aphids tend to rise away from the ground, partly because of a photo-tactic response to the sun which is then high in the sky, and partly, probably, because they are carried up by the convective activity which develops markedly in hot, sunny weather. Mass flights near the ground occur particularly on dull, over-cast, warm evenings and may occur also during the day in such weather. Second, it is usual for the wind to slacken toward evening thus releasing "pent-up" flight activity, for aphids will not take off in much wind.

As to the second question, concerning probable differences between host-alternation principles in different aphid species, I fully concede the probability: each case must be studied on its own merits. But a discussion on how far the principles suggested by the study of *Aphis fabae* are of general application would take too long.

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## IS *BOMBUS AGRORUM ROMANIOIDES* KRÜG. A RELICT FROM DOGGERSLAND?

By G. Kruseman

From the studies of the British Entomologists and of the Dutch Lepidopterologist, Mr. Lempke, it is evident, that many species of insects on the east and west-coast of the North Sea are consubspecific, while the subspecies of the eastern provinces of the Netherlands have a population of Central European subspecies. The explanation is that in the upper holocene till boreal times, the North Sea and Great Britain were a part of the continent. The part of the continent now on the bottom of the North Sea is called Doggersland by our British colleagues.

Doggersland was inhabited by many western subspecies of insects. The general rising of the sea level separated at last in Doverstreet, England, from the continent and cut the area of these Western subspecies in two.

I think there are other examples of insect distribution in accordance with Doggersland, for instance *Bombus cullumanus* Kirby, its distribution along the coasts of the Baltic and North Sea (Sleeswich and the Dutch islands: Ameland and Terschelling) to Southern England suggests an invasion from the eastern European steppes via Doggersland to England.

To my knowledge the distribution of *Bombus agrorum romanioides* Krüg. is the only example of a Dutch insect, whose nearest relations are living in Norway. I will call this insect with the name *agrorum* F. (nec Gmelin) as it is the best known name, but I think under the international rules it must take the name: *pascuorum* Scopoli.

The common *Bombus agrorum* is one of the most interesting species, for it is split up into many subspecies.

Reviewing these subspecies we see, that in the North and East of Europe we find subspecies of the bicolor type. The thorax is dark brown (brown as *Bombus hypnorum*), the first segments of the abdomen are black and the last segments brown. This group of races is distributed in Western part of the Netherlands, in Norway, mid and Northern Sweden, Finland, Russia, Roumania, Bulgaria.

To the south and west of these subspecies in Central Europe we find a group of races with lighter brown thorax and with many yellow hairs on the abdomen. I will call this group the *floralis* group after the oldest name for the central European subspecies. This group is distributed North of the Balkan and the Alps, through Northern France towards England and Ireland.

South of the Alps and in Southern France and Spain there are many other races not of importance for the problem here under discussion. The race of the Scottish Highlands *Bombus agrorum septentrionalis* Vogt must be mentioned here, it is a very yellow insect not nearly related to any of its neighbours. Between the typical *floralis* group and the bicolor group we find in Southern Sweden and Denmark some races (*barcai* Vogt, *mniorum* F. and *mnioides* Krüg.) which I will include in the *floralis* group.

The race *romanioides* of the Western Netherlands is at all sides enclosed by races of the *floralis* group. If we observe its range somewhat closer, we find that the narrow stripe of coastland some 80 km deep between the mouth of the river Schelde and the inlet of the North Sea, called the Louwerszee, is composed of an eastern part some

30 km broad, of Pleistocene deposits and a Western part some 50 km broad of young holocene deposits. It is very remarkable, that in so narrow a stripe of mostly very young country deposited after 5000 b.C. has a subspecies of its own. It was only a very narrow stripe of pleistocene deposits, that remained above sea at the time, that the North Sea had its greatest extension in holocene times. Here survived *Bombus agrorum romanoides* pressed in between the North Sea and the region inhabited by *Bombus agrorum floralis*. I think this area is rather small to develop a new subspecies with affinities to the Scandinavian races, which are supposed to have inhabited the plains along the North Sea in Praeboreal times.

To explain the occurrence of this very local subspecies, there are two possibilities if we exclude the formation of this race in very recent times:

1. The races forming the bicolor group have once in Praeboreal times inhabited the plains along the North Sea and Baltic and have followed the Pine woods towards Sweden and Norway in Boreal times. The races of the *floralis* group are of old Atlantic origin, for they now inhabit England and Ireland besides large parts of Europe. *Bombus agrorum floralis* will probably have settled in these parts of Europe North of the Alps and the Balkan in the warm Boreal time, pressing the races of the *Bombus agrorum bicolor* group to the North and towards the North Sea.

If this is true the range now inhabited by *Bombus agrorum romanoides* is a relic of its area once occupied in Central Europe, but it is queer, that a subspecies probably coming from the South West should not have occupied this small coastal strip, being in its way of wandering.

2. The second explanation is that before 5000 b.C. the race of the bicolor group inhabited not only Northern Europe, but also a part of the North Sea and survived in the narrow coastal strip of the Netherlands, being drowned in the rest of its area. In this case it is a relic of Doggersland.

Certainly it is not a new comer, as all new Northern migrators (plants as well as animals) have a distribution through Sleswick-Holstein, Northern Germany to the line Koevorden—Zwolle—Arnhem—Rotterdam so total different from the area of *Bombus agrorum romanoides*.

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## ÜBER DIE INSEKTEN DER KÜSTENGEWÄSSER DES BALTISCHEN MEERES

Von *Håkan Lindberg*

In weiten Teilen der Küstengebiete im nördlichen und mittleren Baltischen Meer liegt der Felsengrund nackt im Tage. Wo das Felsenufer gegen offene Gewässer grenzt, hat der Wellengang die Felsflächen glattgeschliffen und eine Anhäufung von losem Erdmaterial verhindert. In den Spalten und Vertiefungen des Felsens sammelt sich Regenwasser an, und es entstehen grössere und kleinere Wasseransammlungen. Mehrere von diesen Felsentümpeln sind ganz ephemär, die anderen sind dauernder. Durch die Landhebung werden die Felsentümpel allmählich höher aufs Land versetzt und verändern nach und nach ihren Charakter. Die dem Ufer am nächsten gelegenen Tümpel liegen im Sprühbereich der Brandung und führen daher mehr oder minder salziges Wasser, weiter oben ist das Wasser der Wasseransammlungen süß. Wenn der Wellenschlag den Tümpelrand nicht mehr erreicht, können Gras und Moosbülten in den Ecken gebildet werden, allmählich nehmen sie den grössten Teil der Wasseransammlung ein, und schliesslich verwächst diese vollends. Die oben auf den Schäreninseln des Küstensaumes vorkommenden Kleinsümpfe und Vertiefungen mit *Sphagnum* sind einst als vegetationslose Felsentümpel dicht an der Uferlinie entstanden.

Die Anzahl der Felsentümpel ist in gewissen Küstengebieten, vor allem in den inselreichen, sehr gross. Auf etwa 70 Felsen- und Schäreninseln in der sog. Schärenzone ausserhalb der Zoologischen Station Tvärminne in Südfinnland wurden innerhalb eines 6 km<sup>2</sup> grossen Gebietes über 1200 Felsentümpel gezählt.

In den jüngeren Felsentümpeln ohne oder mit sehr weniger höherer Vegetation dominieren folgende fünf Insektenarten: *Deronectes griseostriatus* De G., *Gyrinus opacus* Sahlb., *Sigara carinata* Sahlb., *S. producta* Reut. und *Gerris thoracicus* Schumm. Die Zozönose umfasst dazu noch verschiedene Chironomiden und Culiciden nebst Plankton und anderen Kleintieren. In Tümpeln mit salzigem Wasser gedeihen Larven von Salzfliegen, *Ephydra*. Die erstgenannten fünf Insektenarten sind Raubtiere, die einander sowie Planktontiere und Mückenlarven verzehren. Diese letzteren leben von Planktonalgen und organischem Bodenschlamm. Die verschiedenen Mitglieder der Zozönose sind somit netzartig miteinander assoziiert.

Mit zunehmendem Alter der Felsentümpel verändern sich die Milieufaktoren und damit auch die Zusammensetzung der Zozönose. Die reichere Entwicklung von Moosbülten und anderer Vegetation verursacht eine grössere Anhäufung von Bodenschlamm und eine Dunkelfärbung des Wassers sowie eine Steigerung der Azidität. Von den *Sigara*-Arten verschwindet die hellere *carinata*, während die dunklere *producta* noch übrig bleibt. Der in hellerem und schwach salzigem Wasser gedeihende *Deronectes* wird von anderen, dunkleren Wasserkäfern, *Hydroporus melanocephalus* Marsh. und *H. tartaricus* Lec. verdrängt. Die auf dem Wasserspiegel lebenden *Gerris thoracicus* und *Gyrinus opacus* sind, so lange noch eine freie Wasserfläche vorhanden ist, gleichfalls noch zugegen. In dem Wirrwarr von Hypnum und Algen bewegt sich die *Gyrinus*-Larve, hier jagen auch die raubgierigen Larven zweier *Hydrophiliden*, deren phytophage Imagines sich vor allem an den Blättern von Hypnum ernähren, *Hydrobius fuscipes* Rasse rottenbergi Gerh. und *Enochrus quadripunctatus* Rasse sahlbergi Fauv.

Als Irrgäste treten — weniger in den vegetationslosen als in den vegetationsreichen Felsentümpeln — einige Wasserkäfer und andere Insekten auf, die den Tiergesell-

schaften der Teiche, Seen und Sümpfe des Festlandes angehören. Wenn sodann die Vegetation den Felsentümpel zum grössten Teil auszufüllen beginnt, und dieser in einen Kleinsumpf oder ein Moor verwandelt wird, engen sich die Existenzmöglichkeiten der eigentlichen Felsentümpelarten ein, und es treten allmählich gemeine und weit verbreitete See- und Teicheinwohner an ihre Stelle.

Studiert man die Verbreitungsverhältnisse der dominierenden Felsentümpelinssekten in Fennoskandien, so findet man, dass da zwei voneinander getrennte Verbreitungsgebiete existieren. Das eine umfasst die arktischen und subarktischen Zonen und den nördlichsten Teil der Nadelwaldzone im nördlichsten Fennoskandien sowie die alpinen und subalpinen Zonen der anschliessenden höheren Gebirgsgegenden. In nördlicheren Ebenen, z. B. in Nordfinnland erstreckt sich das Verbreitungsgebiet der betreffenden Arten südwärts etwa bis zum Polarkreis.

Das andere Verbreitungsgebiet der Felsentümpelinssekten umfasst die Küsten im südlichen und mittleren Fennoskandien. Ausserhalb der Küstengebiete, wo der Felsen grund an den Tag tritt und Felsentümpel gleichfalls zu finden sind, kommen diese Arten nicht vor. — Ausserhalb Fennoskandiens besitzen Felsentümpelinssekten eine hochnordische und arktische Verbreitung, einige boreoalpine Arten kommen ausserdem in Gebirgs- und Alpengebieten Grossbritanniens und des südlichen Mitteleuropas vor.

Man kann annehmen, dass die Felsentümpelinssekten wie die meisten anderen hochborealen und arktischen Arten von ihren ehemaligen Aufenthaltsorten in Mitteleuropa schon früh nach dem Verschwinden des Landeises die freigelegten Gebiete Fennoskandiens besiedelten. Nach der Lebensweise und der rezenten Verbreitung dieser Arten zu urteilen, erbieten sich ihnen zusagende Standorte in der Nähe des zurücktretenden Eisrandes. Bei der fortschreitenden Klimaverbesserung wurden sie als Folge der Konkurrenz seitens anderer Arten meistens von ihren Positionen im Binnenlande vertrieben, sie hielten sich aber als Relikte in den Küstengebieten, wo ihnen auf dem noch nackten Felsgrund mit seinen Wasseransammlungen geeignete Biotopen zu Gebote standen. Auf Grund der Landhebung hat sich ihr Verbreitungsgebiet ständig vom Ausgangspunkt meerwärts verlegt. Sie treten jetzt in den gegenwärtigen Küstengebieten sowie an der Nordküste des Ladogasees als Pseudorelikte auf. Einige Arten, wie *Gyrinus opacus* und *Deronectes griseostriatus*, weisen auch spärliche Reliktorkommnisse im Binnenlande auf.

Die Felsentümpelinssekten sind nicht die einzigen in den Küstengebieten des Baltischen Meeres und des Ladogasees vorkommenden Organismen mit arktischer und hochnordischer Verbreitung. Bekanntlich bietet die Küstenzone geeignete Standorte auch z. B. einer Anzahl hochnordischer Pflanzen und Landinsekten dar. Man kann dieses Phänomen mit einem Hinweis auf gewisse klimatische Ähnlichkeiten zwischen den Küstengebieten und den hochnordischen Regionen erklären. In den äusseren Küstenzonen tritt der Frühling stark verspätet ein, wodurch die Mai- und Juni temperaturen eine gewisse Übereinstimmung mit den entsprechenden Temperaturen in Lappland erlangen. Aber nicht nur in betreff der Temperaturverhältnisse herrschen Übereinstimmungen zwischen den Meeresfelsen an den Küsten Fennoskandiens und der spärlich bewachsenen arktisch-alpinen Zone in hohen Norden und in den Fjelden. Man kan die Felsenflächen mit ihren Moos-, Gras- und Kräuterbüten und Wasseransammlungen als eine Art infolge der Landhebung ständig gegen den Meeressaum vorrückende Reliktstandorte aus der Zeit des Abschmelzens des Landeises betrachten.

Auf den nackten Meeresfelsen mit ihren Wasseransammlungen stehen also noch für

hochnordische Wassertiere geeignete Standorte, die dagegen für mehr fordernde, später eingewanderte Arten als ausgesprochen ungastlich zu gelten haben.

Neben den hochnordischen Insekten treten in den Felsentümpeln an diese extremen ökologischen Verhältnisse angepasste Rassen von Arten auf, die in weiter verbreiteten Standortstypen der Umgebung leben. Solche Felsentümpelarten sind die Käfer *Hydrobius fuscipes* Rasse *Rottenbergi* und *Enochrus quadripunctatus* Rasse *sahlbergi*.

Ich werde jetzt von den Insekten im Baltischen Meere selbst sprechen. In der Fisch-, Krebstiere- und Molluskenfauna des Brackwassergebietes des Baltischen Meeres kann man grob zwischen Meerestieren und Süßwassertieren unterscheiden. Die erstgenannten sind aus umgebenden salzigen Meeren eingewandert, die letzteren haben das Brackwassergebiet aus naheliegenden süßen Gewässern erreicht.

Sämtliche Wasserinsekten sind, wie bekannt, ursprünglich Süßwassertiere, nur eine geringe Anzahl hat sich an ein Leben im salzigen Wasser angepasst. In dem schwach salzigen Wasser des Baltischen Meeres gedeihen eine Menge Insekten; in den innersten Teilen der Meeresbuchten, wo der Salzgehalt sehr gering ist, dürften beinahe alle Wasserinsekten der Umgebung auftreten können. An offenen Ufern in den mittleren und südlicheren Teilen des Baltischen Meeres, wo das Wasser einen Salzgehalt von 6 ‰ und mehr aufweist, kommt dagegen nur eine geringere Anzahl von Insektenarten vor. So sind z. B. aus den Biozönosen dieser offenen Ufergewässer nur ganz bestimmte Wasserkäferarten zu nennen. Nur ein geringer Teil derselben kommt daneben in den innersten Buchten und in süßen Gewässern der Umgebung vor. Die meisten von diesen, wie ich sie nennen möchte, typischen Brackwasserinsekten haben in Nordeuropa ihr hauptsächlichstes oder ausschliessliches Vorkommen an den Ufern des Baltischen Meeres. Hier meiden sie jedoch die Felsenufer wie auch die einer stärkeren Wellenwirkung ausgesetzten vegetationslosen Ufer.

In Bodenschlamm der niedrigen Sand- und Mjälaufer leben Arten der Gattung *Laccobius*, ihre Larven in Ballen von Fadenalgen dicht an der Uferlinie. Die häufigste *Laccobius*-Art ist *L. minutus* L., neben dieser kommt die interessante *L. decorus* Gyll. vor. Die Verbreitung der letzteren Art umfasst die nördlichen und mittleren Küsten des Baltischen Meeres und ausserdem die Salzgebiete östlich des Kaspischen Meeres. Eine Untersuchung der Algenbestände eine kleine Strecke ausserhalb der Uferlinie zeigt, dass sie mehrere Arten der Gattung *Haliplus* beherbergen. Die *Halipliden* sind bekanntlich sowohl als Larven wie im erwachsenen Stadium Pflanzenfresser und sind an spezielle Charazéen und Fadenalgen (*Cladophora*) gebunden. Im Meere an unseren Küsten kommen u. a. folgende *Haliplus*-Arten vor: *immaculatus* Gerh. *obliquus* F., *flavicollis* Sturm, *confinis* Rasse *pallens* Fowl. und südlicher in der Ostsee *apicalis* Thoms.

In betreff der Verbreitungsverhältnisse dieser *Haliplus*-Arten kann folgendes hervorgehoben werden. Die häufigste Art an unseren Küsten ist *H. immaculatus*. Die Art lebt an *Cladophora* und kommt am zahlreichsten in geschützten Buchten vor. In den südlicheren Teilen seines Verbreitungsgebietes (in Mitteleuropa und Südeuropa sowie in angrenzenden Teilen von Afrika und Asien), d. h. nördlich bis Norddeutschland und dem südlichsten Schweden, ist dieser Käfer ein typischer Süßwasserbewohner, in den mittleren und nördlichen Teilen des Baltischen Gebietes kommt er ausnahmslos im Brackwasser der Küsten vor. Aus Finnland liegt ein Binnenlandsfund vor, in Schweden ist die Art an wenigen Stellen auf der mittelschwedischen Ebene angetroffen worden. Im Gegensatz zu *immaculatus*, der bis in die nördlichsten Teile des Bottnischen Meerbusens verbreitet ist, kommen die Arten *flavicollis* und *obliquus* am nördlichsten an

der Süd- und Südwest-Küste Finnlands vor, *apicalis* wie gesagt nur in der südlichsten Ostsee. Von diesen drei Arten ist wenigstens *flavicollis* auch im Binnenland (in mittelschwedischen Seen und in Joutseno in Südfinnland) gefunden worden.

Ähnliche Verbreitungsverhältnisse wie die *Haliplus*-Arten haben auch einige andere Insekten, u. a. einige Wasserkäfer, wie *Noterus clavicornis* De G. und *Enochrus melanocephalus* Ol. aufzuweisen. Der Wasserläufer *Gerris thoracicus* kommt im nördlichen und im mittleren Teil des Baltischen Gebietes nur dicht am Meere vor, im südlichen Teil sowie noch weiter südlich ist auch er ein weit verbreiteter gewöhnlicher Süßwasserbewohner. — Im Gegensatz zu den echten Halobionten habe ich die hier geschilderte Gruppe von Wasserinsekten Pseudohalobionten genannt.

Die gegenwärtige Verbreitung dieser Pseudohalobionten kann meines Erachtens auf zweierlei Weise erklärt werden. Der Schwerpunkt in ihrer Verbreitung liegt, wie schon früher erwähnt wurde, in den südlichen Teilen der erosisibirischen Region (z. B. in Mitteleuropa), hier leben sie also in süßem Wasser. Man kann sich denken, dass diese Süßwassertiere einst geeignete Möglichkeiten zu einer Ausbreitung nordwärts längs den Ufern des süßen Ancyclus-Sees gefunden haben. Dieses Gewässer erstreckte sich bekanntlich nicht nur über das gegenwärtige Baltische Meer, sondern weit über heutige Festlandsgebiete. An den Ufern des grossen Sees wurde den fraglichen südlichen Arten ein in klimatischer Hinsicht günstiges Milieu dargeboten. Besonders günstig für eine Ausbreitung dieser südlichen Arten lagen die Verhältnisse während der am Ende der Ancyclus-Periode einfallenden Wärmezeit. Als Relikte haben sich einige Pseudohalobionten an geeigneten Stellen im Binnenland am Strande des ehemaligen Ancyclus-sees erhalten. Die Hauptstämme dieser Insektenarten sind hingegen gezwungen gewesen, dem zurückweichenden Ufer des verhältnismässig warmen baltischen Wasserbeckens zu folgen; hier sind sie, weniger empfindlich gegen die Schwankungen des Salzgehalts, während der nachfolgenden Litorina-Zeit und bis in die Gegenwart erhalten geblieben.

Zur Erklärung der Verbreitung der Pseudohalobionten kann man auch auf andere Milieufaktoren als die klimatische hinweisen. So könnte wahrscheinlich die Azidität des Wassers für die Verbreitung einiger Wirtspflanzen und auf diesen lebenden pflanzenfressenden Tieren ausschlaggebend sein. Unter anderem dürften einige Algen besser in alkalischem als in saurem Wasser gedeihen. Ein geeignetes Medium steht diesen sowie den auf ihren lebenden Tieren in Seen auf alkalischem Grunde in Mitteleuropa zur Verfügung. Weiter nördlich, wo die süßen Gewässer eine mehr oder weniger saure Reaktion haben, bieten nur das Brackwasser in Baltischen Meere sowie die Seen auf Kalkgrund auf Öland, Gotland und teilweise in Mittelschweden sowie an vereinzelter Stellen in Südfinnland den betreffenden Pflanzen und Tieren eine passende Lebensumgebung dar. An ihrer Nordgrenze im Baltischen Gebiet dürften auch einige höhere ausspruchsvolle Pflanzenarten am besten auf Kalkgrund gedeihen. Wahrscheinlich gilt dieses auch in betreff der Tiere.

Die Insektenfauna der Küstengewässer des Baltischen Meeres umfasst aber auch noch einige echte Halobionten. Solche sind z. B. die Ruderwanze *Sigara stagnalis* Leach. und die Hydrophiliden *Ochtebius marinus* Payk., *Enochrus bicolor* F. sowie *Berosus spinosus* Stev. Diese Vertreter einer unter den Insekten wenig repräsentierten ökologischen Gruppe kommen auch an den Küsten anderer Binnenmeere sowie an Weltmeerküsten und in Salzseen der Binnenländer vor. Ein echter Halobiont ist auch die früher genannte Hydrophilide *Laccobius decorus*.

Wie die Pseudohalobionten sind auch die Halobionten Vertreter eines südlichen Elementes in der Fauna des Ostseegebietes. Einige derselben kommen nur im süd-



lichsten Teil des Gebietes vor, andere sind bis in die nördlichsten Teile des Bottnischen Meerbusens verbreitet.

Die für das Brackwasser des Baltischen Meeres typischen Insekten repräsentieren somit ein biogeographisch ganz anderes Element als die Insekten der Felsentümpel, die, wie oben angeführt, der Hauptsache nach einen hochnordischen Einschlag in der Wasserfauna der Küstengewässer vertreten. Nur ganz ausnahmsweise tritt ein Felsentümpelinsekt im Meere selbst auf, die typischen Brackwasserinsekten fehlen gänzlich in den Felsentümpeln. Es ist somit von Interesse festzustellen, dass auf weiten Küstenstrecken des Baltischen Meeres dicht beieinander zwei Arten von Biotopen vorkommen, von denen die eine Lebensbedingungen für eine Zoozönose mit ausgeprägt südlichen Arten darbietet, die andere wieder seit ehemals eine Tiergesellschaft von hochnordischen Arten hat beherbergen können.

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## NEW ENTOMOLOGICAL EVIDENCES OF A FORMER TRANS-PACIFIC LAND-CONNECTION

By René Malaise

I have recently received for determination a small collection of saw-flies (*Hymenoptera Tenthredinoidea*) from New Guinea collected by Dr. Toxopeus in 1938. The collection consists of 117 specimens, and only one species, *Cladomacra macropus* Smith in 5 specimens, were previously known to science, and actually coming from New Guinea and also from the island of Celebes. Eight specimens, representing 3 species, belong to the two Australian genera *Perga* and *Pterygophorus*. The remaining specimens, except one that is broken, may be referred to two genera new to science. One of these genera belongs to the *Strombocerina* Group, and consists of a few different species or subspecies, and shows great affinities to the multitude of *Strombocerina* genera and species in the Subtropical Region, but with only single representatives in Insulindae and Malaya. The remaining 29 specimens belong all to one species, and the genus is new and closely related only to some small genera from Chile and Brazil, but not represented either in Australia or in any other continent but South America. It is not only the singular wing venation that shows such a striking relationship, but also in other characters the close affinity is evident.

If only a single specimen had been found, and that specimen had shown more or less vague characters resembling species from another continent, then the matter could have been put aside and neglected. Now the overwhelming majority of the saw-fly fauna from the interior of New Guinea points to an origin from across the entire Pacific Ocean, and, according to an information in a letter from Dr. Lieftinck of the Buitenzorg Museum, also among the *Odonata* similar relations to the South American fauna may be traced. Australia and South America are already from old known to have some rather ancient forms in common, but New Guinea was supposed to have got its fauna mainly from Australia and only to a lesser part from the Oriental Region.

This most startling occurrence of exclusively South American insects in New Guinea brings forward the question how they could have arrived to this island, and by what way?

Primitive Mammals, related to those of Australia and South America, are generally supposed formerly, during the Eocene Period at the beginning of the Tertiary, to have been distributed all over the world, and later remained more or less isolated only in the named two continents. Regarding plants, and also animals, connections between Australia or New Zealand on one side, and South America on the other, are usually supposed to have occurred during the Tertiary over the Antarctic Continent, either by continental drift or else with the help of now sunken land-bridges. If our insects should have arrived to New Guinea from Chile that way, one might expect that at least traces of similar forms should have remained until to-day either in Australia or in New Zealand, but no forms related to those collected by Dr. Toxopeus are hitherto known from either of these places. There remains accordingly only to think of a more direct connection across the entire Pacific Ocean.

The probability of a former existence of such a Trans-Pacific connection seems at first most improbable, especially as additional evidences from intermediate smaller

islands are wanting. The occurrence in New Guinea of South American elements would accordingly remain inexplicable.

That land-connections existed between New Guinea and Australia during the Great Ice Age nobody can seriously deny. The separating Torres Strait is so shallow as to make it next to certain that a land-connection over it existed during all of the Glacial Stages of the Quaternary, when the oceans were deprived of large quantities of water to feed the growing ice-caps of the poles and of the enlarged glaciers the world over. It has been estimated that the water level of the oceans then sank about 100 metres owing to this cause, and Torres Strait is not as deep as that. An interchange of animal forms must accordingly have existed over this land-bridge during the Great Ice Age, and the occurrence of the genera *Perga* and *Pterygophorus* in the collection of Dr. Toxopeus bears evidence of such a connection.

One should expect that specimens of such a multiform and vigorous group as *Strombocerina* also should have occurred in Australia. Their wanting there can only be explained as these insects must be bound to higher altitudes and do not occur in the low-land and thus never were able to cross the low land-bridge to Australia when opportunity was offered. That they nevertheless should have arrived from Australia to New Guinea without leaving any traces behind must be regarded as most improbable, as suitable places for them in the mountainous parts of the Australian Continent are plentiful. It may on the other hand be argued, that the *Strombocerina* of New Guinea may have arrived there from the Oriental Region, where forms related to South American genera do occur, although only rarely, but it is generally considered that, as a rule, the centre of distribution of a genus or of a group is to be looked for in the same place where it is more multiform. It is accordingly more likely the Oriental genera should have arrived there from New Guinea, than that the distribution should have taken the reversed way.

Geologists hesitate as a rule to accept the possibility of former existence of trans-ocean land-bridges. The majority of them avoid altogether to express any opinion about this question; some have accepted the theory of a permanency of continents and of oceans, and other again believe in continental drift in the sense of Wegener. In a paper published in 1945, I have opposed both these theories and instead accepted the "Constriction Theory" of Professor Odhner of Stockholm. According to his theory, all the major changes in the topography of the earth's crust ultimately are to be put down to the influence of the heat from the interior of the earth.

I cannot here explain in detail his theory, but the general idea is, that the low and very broad wrinkles or vaults of which the earth's crust is composed, that is the geosynclines and geanticlines, if not cooled by air or cold water, will expand owing to the heating from beneath. The geosynclines or descending vaults are represented on the earth's surface by marin basins or low-lands, and the geanticlines or elevated vaults by the more mountainous parts of the crust. As the different vaults keep one another in place by the lateral pressure, an expansion from heating from below would result in an accentuation of the curvature of the different vaults.

During the warm Tertiary the earth's crust was heated from below without being cooled, and the continents were thus overelevated and the bottom of the marin basins pressed down to extreme depths. As a consequence, the water of the oceans was then accumulated into these abyssal depths, and the summits of the continents reached so high up into the atmosphere that they were subject to glaciation. This concentration of the ocean water into comparatively limited and very deep basins resulted in large

parts of the present oceans to become dry land at the end of the Tertiary. This will explain the otherwise baffling existence of the submarine canyons, sometimes dug out more than 1000 meters below the surrounding seabottom, and extending down to a depth of 3000 meters or more outside the mouth of many rivers all over the world.

This overelevation of the continents and the subsequent glaciation of the highest summits resulted in a deterioration of the warm Tertiary climate, ultimately culminating into the Great Ice Age. When the cold water from the melting glaciers reached the oceans, it accumulated at the bottom of the marine basins and cooled these. The result was that gradually the deeper layers below the bottom of the basins also were cooled, and began to constrict. The constriction of these subcrustal layers caused the basin bottoms to lessen their curvature, and as a consequence the water-level of the oceans rose again. The water rose then so rapidly up to near its present level, that the former topography was preserved so well as to enable us to study even the most detailed river-system of the former landscape, now several thousands meters below the surface of the water.

Before this transgression, great parts of the present ocean bottom must have remained above sea-level since the Pliocene period of the Tertiary, and remained so until the beginning of the Quaternary, providing excellent possibilities for animals and plants to spread from one continent to another.

From a study of diagrams of the different sedimentation in the Atlantic Ocean, on both sides of the Mid-Atlantic Ridge, it was possible for me to prove definitely, that this ridge had been above the surface as a continent during the Tertiary, and remained so until well after the Glacial Period when it sank, owing to the constricting influence of the cold water.

In the Pacific Ocean we do not know much of the topography of the bottom, but it can hardly be doubted, that this topography has about the same character as in the Atlantic or in continents, with mountain ranges and occasionally level basins. During the war the American fleet discovered by sounding in the Pacific large tracts of submarine mountains reaching almost up to the surface of the sea where hitherto it was believed to exist depths of several thousands metres. It is known that a submarine elevation of the ocean bottom over Tahiti keeps the coldest bottom-water, coming from the Antarctic Ocean, away from the main part of the Pacific. I have advanced the theory that a retardation of the general transgression, otherwise felt all over the world, occurred in the northern part of the Pacific, owing to the influence of this ridge that probably was over-flowed by the rising water only comparatively late in the Quaternary.

The existence of former land of large extent in the Pacific cannot be seriously doubted, and the results of the deep-soundings executed by the Swedish Deep-Sea Expedition 1947—48 has in the main confirmed the former existence of land in the Pacific, apparently against the expectations of the leader, Professor HANS PETTERSSON. From preliminary reports in newspapers it is evident that the Expedition, when starting, believed either in the Wegener Theory of Continental Drift, or else in the permanency of the oceans. Wegener's Theory was openly rejected after that the rough nature of the bottom of the Atlantic successively appeared as a result of soundings made during the crossing, but in the Pacific, the influence of lava-beds from "Submarine eruptions" were always blamed when the sounding device met hard bottom after having penetrated but a few metres of soft sediments, where samples of such soft mud were expected of a length of 20 meters or more. The obtained core-

samples changed also frequently their deep-sea character lower down to a more shallow-water clay, indicating a former closer proximity to some continent or a former lesser deepness than the present 3 or 4000 m.

Had the ocean been permanent, the sediments ought to have been rather homogeneous and reach down thousands of meters. From seismologic studies of detonating sunk-bombs with vaves reflecting from the hard granite core itself, the covering layers of sedimentary rocks, less hard than crystalline ones, were found to be not deeper than on continents that have for long been exposed to erosion above water. The former existence of large tracts of dry land in the Pacific, where it is now several thousands metres deep water, may accordingly be regarded as undeniable. These now sunken continents may quite well have been connected with both New Guinea and the South American Continent during the Tertiary, and remained connected until well into the Quaternary. The evidences given by the saw-fly fauna of New Guinea of the existence of a former Trans-Pacific land-bridge may accordingly be regarded as most important, and such a theory is also supported by strong geological evidences.

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parts of the present oceans to become dry land at the end of the Tertiary. This will explain the otherwise baffling existence of the submarine canyons, sometimes dug out more than 1000 meters below the surrounding seabottom, and extending down to a depth of 3000 meters or more outside the mouth of many rivers all over the world.

This overelevation of the continents and the subsequent glaciation of the highest summits resulted in a deterioration of the warm Tertiary climate, ultimately culminating into the Great Ice Age. When the cold water from the melting glaciers reached the oceans, it accumulated at the bottom of the marine basins and cooled these. The result was that gradually the deeper layers below the bottom of the basins also were cooled, and began to constrict. The constriction of these subcrustal layers caused the basin bottoms to lessen their curvature, and as a consequence the water-level of the oceans rose again. The water rose then so rapidly up to near its present level, that the former topography was preserved so well as to enable us to study even the most detailed river-system of the former landscape, now several thousands meters below the surface of the water.

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## NOTES ON THE POMPILIDS SPECIES IN THE CARPATHIAN BASIN (HYM.)

By L. Móczár

The basic work on the Pompilid fauna of the Carpathian Basin (see map I) is Mocsáry's Catalogue (1897), containing only the localities of occurrence of determined species. Since then, numerous collectors enhanced by new collecting data those of the Catalogue. New species, taken into consideration in this paper, were introduced, regarding the fauna of the Carpathian Basin, by Zilahi-Kiss (1915, 4 new species), Haupt (1926—27, 1929, 1941, 6 n. sp.), Mader (1936, 2 n. sp.), Pillich (1937, 22 n. sp.), Sustera (1938, 9 n. sp.), the author (1938, 1944 a, b, c, 1946 b, 13 n. sp.) and in the present publication again 13 new species and 1 new genus for the fauna. Among these, from the Carpathian Basin, Haupt (1929, 1941) described 4, and the author (1944 a, c) 6 new, hitherto unknown, species, marked all by a star (\*) set before the number of the species. Phenologic and flower-visiting data were given by Pillich (1937), while author (1943 a, b, c, 1946 a) enhanced information by new oecologic and ethologic observations and photographs.

In the following I give only a short survey of the Pompilid fauna (112 species) in the Carpathian Basin any detailed discussion will wait its turn. To characterize the distribution of species in the Carpathian Basin I made use of denominations introduced by Pittioni and Schmidt (1942) and expanded by me, instead of the vague locality data. A detailed account of the usefulness of this method I have published on other place (Móczár 1948). They are the following:

1. Species with *stenök eremophil* character. Species belonging to this group are: 1a) the inhabitants of various steppes many originally, Pontic insects. E.g.: *Pomp. obtusus* (see map I); 1b) species living almost exclusively along the Mediterranean shores. *Cr. annulatus* (see map I), *Cr. ichneumonoides*, *An. samariensis*, *Ped. crassitarsis* etc.; 1c) the third group consisting of species also preferring arid, warm, and humid seashores, yet invade further into the continent, too. They live here, however, only in the plains, rising over 200—300 m only exceptionally. *Anosp. orbitalis* (see map I), *Cr. egregius*, *Dic. luctuosus*, *Bat. lacerticida*. Species belonging here extend almost over the whole continent, ranging till Finland, populating dry, sand-dunes, f.i. *P. plumbeus*, *Sophr. pectinipes*, *Pomp. sexmaculatus* etc.—2. *Euryök eremophil*, species, living on the plains particularly, penetrating up also to the oak clearing in lower mountainous regions, e.g.: *Ep. rufipes* (see map II), *Cr. Fabricii*, *Cr. affinis*, *Cr. sexpunctatus*, *Sophr. Magrettii*, *Par. manticata*.

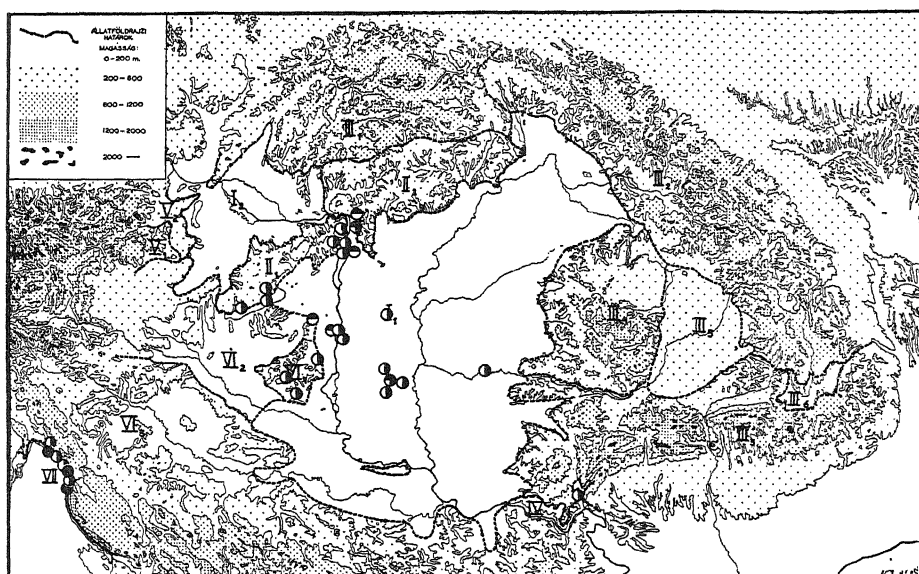
3. *Euryök hylophil* species: frequent in lower and in higher mountains, woods and their clearings. *Pr. vulgaris* (see map III), *Deut. intermedia*, *P. rufus*, *P. ausus*.—4. *Stenök hylophil* species, living only in higher mountains, woody slopes, small plateaus and clearings. *P. usurarius* (see map III), *Deut. bifasciata*.

5. *Hyperuryök intermediär* species can be found everywhere. They are generally common species: *Pseud. carbonaria* (see map IV), *Cr. versicolor*, *Pr. perturbator*, *Pr. mimulus*, *Cal. hyalinatus*, *P. trivialis*, *An. fuscus paganus*, *An. infuscatus*.

The species collected in the Carpathian Basin (see map I—IV) are as follows:

I. Subfam. *Pepsinae* Ashm.—*Cryptochilus* Pz. Species of this genus are dispersed





Map I Distribution of species with stenök eremophil character: ● *Pomp. obtusus* (I a); ● *Cr. annulatilus* (I b); ● *Anosp. orbitalis* (I c). "Allatföldrajzi határok" = Zoogeographical borders. "Magasság" = Altitude. (Orig.)

preponderantly in the *M.*<sup>1</sup>, eremophil, thermophil and fond of dryness.—1. *Cr. annulatilus* (Richards). Easily recognized species, with *1b*<sup>1</sup> character (see map I), *M*<sub>1</sub>.—2. *Cr. egregius* (Lep.). On the 2nd tergite of a few larger females, originating from central localities of the Great Plains, there are a pair of small ivory white spots. Vividity and extension of the red 1st and 2nd abdominal segments is also different. Typical *1c*. *M.* to the *E.* and the Southern Russian steppes.—3. *Cr. notatus* (Rossi). Though data mention it from various parts of the Carpathian Basin, we do not possess one single proving specimen. Its Hungarian occurrence is dubious.—4. *Cr. affinis* (Lind.). Mandibles and antennae not uniform. Four specimens from various localities have mandibles so short and toothless that do not meet in the middle. On eight other specimens from other parts they are somewhat longer, but still toothless, a weakly developed groove indicating the place of the teeth. Proportion of the 3rd segment to the first two is varying. Probably 5, tending to eremophily. From *Atl.* to *M.* and the Near East.—5. *Cr. confinis* Hpt. *1c*, it seems to be a Western *M.*—6. *Cr. Szabó-Patayi* Móczár. Distributed in the Great Plains and in the mountains till 600 ms above s. l.—7. *Cr. ichneumonoides* (Costa). *1b*, in the Eastern *M.*—8. *Cr. similis* Hpt. Syn.: *Cr. Costai* (Rad), according to Junco (1943). Rare *1c*, known from Spain.—9. *Cr. sexpunctatus* (F.). A typically 2, chequered with light spots. From *M.* to the Moravian Basin.—\**Cr. s. forma nigripes* Costa. Four specimens from the Great Plains correspond with Junco's description (1943).—10. *Cr. Fabricii* (Lep.). There is

<sup>1</sup> As regards the oecologic character and distribution of the species see abbreviations: *1 a*, *1 b*, *1 c*, 2—5 as above; *Pal.*: Palearctic fauna dominion, *M.*: Mediterranean fauna province, *E.*: Euro-turanian fauna province, *S.*: Sibirian fauna province, *Balt.*: Baltic fauna distrikt, *Atl.*: Atlantic f. d.

one some specimens a thin light strip also on the 5th tergite. The 1st and even the 2nd tergite are partially light red on some specimens of the Southern parts of the territory under discussion. A characteristic 2, in *M.* to the Southern *E.*, and to the Southern Russian steppes.—\*11. *Cr. fulvicollis* (Costa). Related to *elegans*, but of larger size. 1c, known only Sardinia, Naples and Macedonia.—12. *Cr. elegans* (Spin.). Its red color can take an orange tint, or dark red. Extension of the light spots is also different. Collected only in the South, chiefly in the sea-coast. 1c, from *M.* and Southern Tirol.—\*13. *Cr. bicolor* (F.). Presumably 1c, *M.*—\*14. *Cr. octomaculatus* (Rossi). 1c, *M.*—15. *Cr. versicolor* (Scop.). This species is quite difficult to separate from the next by the sometimes different rugulosity of the propodeum and its arched sides. 5, in the Northern *M.* and the Southern *E.* as far the Caucasus.—16. *Cr. formicarius* (Christ.). More 5 than 2. Distribution is also smaller than of former.—17. *Cr. guttulatus* (Costa). Little known. Collected in the Southern hills and the sea-coast. Recorded from Southern France and Italy.

*Priocnemis* Schdte. The largest number of *Priocnemis* species are distributed in the Northern parts of the Pal., rather in *E.* and *S.*, there by completing the distribution of the genus *Cryptochilus* towards North. Accordingly, there are more hylophil species among their members.—18. *Pr. rugosus* Sust. The rugulose and wrinkled propodeum is not of the same coextension even on the two specimens from Fiume. 1. Balcanic species.—19. *Pr. coriaceus* Dhlb. The shining space of the postnotum is not uniform, broad in some specimens and narrow in others. The chagrined sculpture of the propodeum distinguishes it from other species. Seems to be an 3. *Balt.*, *Atl.*—20. *Pr. perturbator* (Harris). Frequent. Varying in the proportion of the antennal segments, but also, in a small way, the shining space. Typical 5, early vernal, species, in *E.*, *S.*—21. *Pr. Susterai* Hpt. The shining space sometimes extends to triangular. 3, from Middle Europe.—22. *Pr. Enslini* Hpt. Female little known, male easily recognizable by its genital plate. Presumably 3, in Middle Europe, sporadically also in the *Atl.*—23. *Pr. Hankói* Móczár. Caught in a few specimens on the borders of the Hungarian Great Plains and in Lower Austria. Presumably 3, subendemic species.—24. *Pr. Clémenti* Hpt. Very varying. Junco (1947) expounded on the conspicuous differences between, the specimen originating from the Carpathian Basin determined by Haupt and the original description. There are 5 other females caught in lower mountains that differ from the orig. description in the followings: size smaller (7.5—9 mm), lower margin of the clypeus straight, anterior and median tibia mostly, anterior femur and tibia, red. Haupt determined one of these specimens also as *Pr. Clémenti*, in 1943, and I also range such specimens here. 5, tending to hylophil, *Pal.*—25. *Pr. mimulus* Wesm. If the projection on the ventral margin of the clypeus is weak, it is difficult to separate it from *Clémenti*. The form of the shining space is also varying. 5, tending to hylophil, *M.*, *E.*—26. *Pr. vulgaris* (Lep.). Its male questionable (Móczár 1946). 3, see map III. From the borders of the *M.* and *E.*—27. *Pr. hungaricus* Hpt. in litt. This species (♂) is probably the male of the *Pr. vulgaris* (Lep.). As it was figured as a new species on ground of a single Hungarian specimen in the manuscript of Haupt (1943, Halle), I have the other Hungarian specimens which I compared with those of Haupt the same name. 3, endemic.—28. *Pr. Klosei* Hpt. This and the next species is very difficult to separate. 5, *Pal.*—29. *Pr. minor* (Zett.). Presumably 2, *E.*, *S.*—30. *Pr. minutus* (Lind.). Weakly varying. Known mostly from hilly and lower mountainous regions. On ground of its dispersion an 3 in spite of its light red eremophilous character. *M.*, *E.*—31. *Pr. exaltatus* (F.) 5, *Pal.*—32. *Pr. melanosoma* Kohl. Body black,

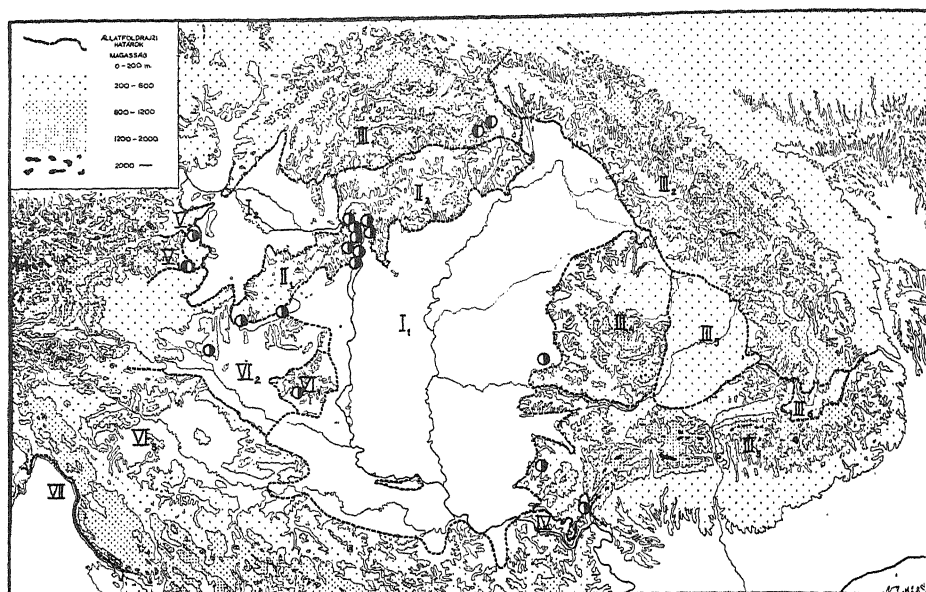


Map. II. Distribution of species with euryök eremophil character: ●  
*Ep. rufipes* (2). (Orig.)

the first abdominal tergite sometimes showing rusty red. Rare 3, apart from *M.*, known Middle Europe.—33. *Pr. femoralis* (Dhlb.). Separation of males from those of the former is not always satisfactorily successful. Shape and sculpture of the genital plate varying. Rare 5, tending to hylophil, *M.*, *E.*—\**Pr. f. forma fennica* Hpt. Collected on the borders of the Plains, known from Finnland, Germany, and Spain.—34. *Pr. obtusiventris* Schdte. 5, *Pal.*—35. *Pr. longicornis* Hpt. Proportion of antennal segments faintly varying. Presumably 3, found also in Spain.—36. *Pr. propinquus* (Lep.). Rare 3, in the Western *M.*—37. *Pr. crassipititis* Móczár. 6 specimens caught in the Plains. A species of conspicuously small eyes, endemic.—38. *Pr. pusillus* Schdte. 5, *Pal.*—39. *Pr. Schiödtei* Hpt. Probably 5, from Middle Europe and Spain.—40. *Pr. cordivalvatus* Hpt. According to data its occurrence is probable. Northern territory of the *Pal.*

II. Subfam. *Macromerinae* Hpt.—*Deuterationia* Sust. Mostly hylophil species, distributed in the colder *E.*—41. *D. variegata* (L.). 3, in the Eastern *M.*—42. *D. erythropus* (Kohl). Proved to be a species bona the type specimens of which I have examined in the Naturhist. Mus. at Vienna. *ib.*, there are some data from the Dalmatian sea-coast and Graece.—43. *D. hircana* (F.). It is very difficult to separate the ♀ from that of *D. nitida* Hpt. 3, *E.*—44. *D. bifasciata* (F.). Margins of the light spots on the wing mostly blurred. 4, *E.*—45. *D. intermedia* (Dhlb.). As the former, but 3, *E.* and Japan.

*Pseudagenia* Kohl. As compared with former genus rather eremophil and widely distributed species belong here.—46. *Ps. carbonaria* (Scop.). The most frequent of all. Longitudinal furrow of propodeum is of different development. Typically 5 (see map IV), in the Western *Pal.*—47. *Ps. albifrons* (Dalm.). A remarkably variably species,



Map. III. Distribution of species with hylophil character: ○ euryöke hylophil, *Pr. vulgaris* (3); ● stenöke hylophil, *P. usurarius* (4). (Orig.)

mostly in the male. Probably 2, *E.* and in the Northern *M.*—48. *Ps. recta* Hpt. Syn.: *Ps. dubia* Hpt. 2, from Middle Europe and Serbia.

III. Subfam. Claveliinae Hpt.—*Calicurgus* Hpt.—49. *C. hyalinatus* (F.). The size and white color in the spots in the male are not equal. Typically 5, *E.* and in the Northern *M.*—*C. h.* forma *Gyllenbali* (Dhlb.). Rare in the Plains and in lower mountains.

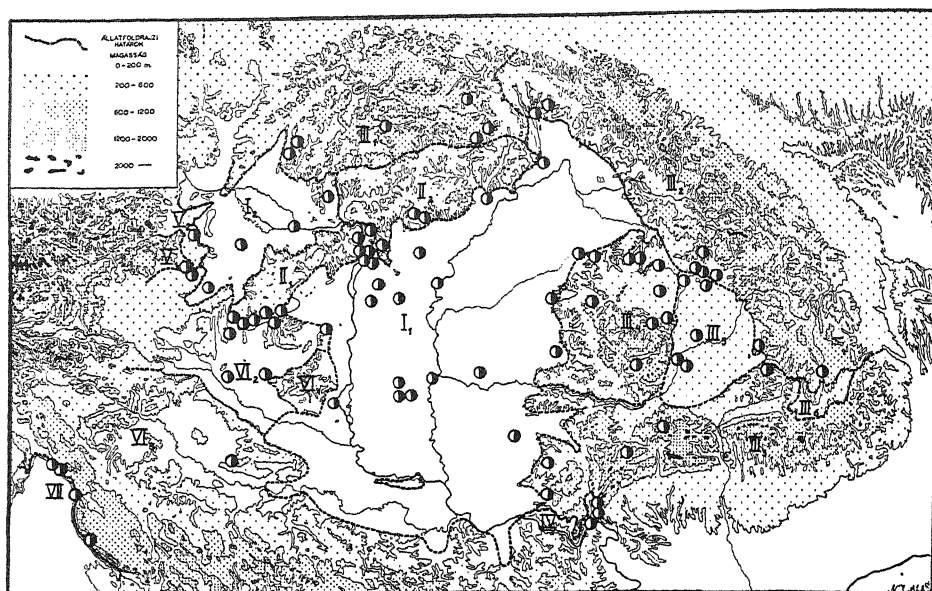
IV. Subfam. Pompilinae Latr.—*Pompilus* F. Chiefly cremophil species of various dispersion belong here.—\*50. *P. haematopus* (Lep.). This extremely rare species has been collected in the sea-coast. 1c, data from Italy, Dalmatia and Middle Europe.—51. *P. plumbeus* (F.). Somewhat varying. The most frequent species of sandy clearings in dry Robinia woods, and dunes. Typically 1c, Western *Pal.*—52. *P. sericeus* Lind. Color of the legs differing. Probably 2, Western *Pal.*—53. *P. hungaricus* (Móczár). I described this species (1944) as *Anospilus*. Since I have intensively examined this specimen and as a consequence I list it in the group of *sericeus*. Chiefly its smooth propodeum bearing no furrow distinguishes it from the former species.—54. *P. cinctellus* Spin. 5, Western *Pal.*—55. *P. nubecula* Costa. Much rarer than the former species, 2, from *M.* to Belgium and the Bohemian Basin.—56. *P. usurarius* Tourn. One female and two males were caught in our higher mountains (see map III), 4, rare Western *Pal.*—57. *P. minutulus* Dhlb. The separation of the Hungarian female specimens of *minutulus* and *fuscumarginatus* often very difficult owing to their tending to variability. Variation of *minutulus* males: small excavation of the hind tibia; the ocelli of 6 specimens are not obtuse-angled but form a right-angle. 5, Western *Pal.*—58. *P. fuscumarginatus* Thoms. Variable, 2 tending to 5, Western *Pal.*—59. *P. spissus*

Schdte. Easily separable from the other owing to its head thickened behind ocelli and with ocelli more narrow than half the front. 5, Western Pal.—60. *P. rufus* (Hpt.). The same width of the temples and eyes distinguishes it chiefly from the related species. 3, Baltic species.—61. *P. fumipennis* Zett. This species is hardly distinguishable from the next one owing to the varying length of antennal segments. Probably 3, Balt.—\*62. *P. nostras* Kohl. Presumably 2, Western E. and Eastern M.—*P. sogdianus* (Mor.) Sustera (1938) recorded a few specimens from Carpathicum (see map I: III1). Species unknown to me, its occurrence probable.—63. *P. unguicularis* Thoms. Syn.: *Psammochares gibbus* Hpt. ♂. 5, Western Pal.—64. *P. ausus* Tourn. Syn.: *Psammochares carinulatus* (Mor.). 3, E.—65. *P. trivialis* Dhlb. Syn. *Psammochares gibbus* Hpt. ♀., *Ps. unguicularis* Hpt. ♂. Variable. 5, Western Pal.—66. *P. gibbominus* (Hpt). Females taken in half the number than the more characteristic males. 1a, endemic.—67. *P. Wesmaeli* Thoms. Rare 2, E. S.—68. *P. abnormis* Dhlb. The antennal segments and clypeus variable. 2, E. and Italy.—69. *P. leucopterus* Dhlb. According to Wilcke (1942) the specimens collected in Holland and determined by Haupt (1927 p. 178) as *leucopterus* may be understand as those of *Sophropompilus crassicornis* (Schuck.). Two kinds of specimens have been taken in the Carpathian Basin. The head of the two specimens described by Haupt is really narrow behind the eyes and postnotum much narrower than in the others; eyes: half the front as 8:15; 3rd antennal segment is equal to the 1st one. The other 30 females with head not narrowed behind the eyes and with the 1st and 3rd segment equal in length differ from the former ones even by following characteristics: the base of the 2nd cubital cell is only a little longer than that of the 3rd one, postnotum much broader; eyes: half the front as 8:17. In spite of this I identified these latter as females of *leucopterus* because there are males in the collection taken at the same locality and at the same time. I could not identify them with *crassicornis* being different in more than one characters (shape of postnotum, its size; shape of antennae, size etc.). 5, in the E. till Italy.

*Sophropompilus* Ashmead. One of the most difficult genera, its system being expounded still unsatisfactorily. Species of eremophil characters belong here.—70. *S. Magrettii* (Kohl). 2, M.—71. *S. pinguicornis* (Hpt.). I could not sufficiently isolate the female of this species from those of *amplicornis* (Hpt.), as I found many transitional forms chiefly in the size of the antennal segments. As I was not able to isolate males of *pinguicornis* illustrated by Haupt (1941) from those of *contemptus* so I ranged the *pinguicornis* males of Wilcke (1943) to this species. 2, E.—72. *S. pectinipes* (L.). Typically 1c, Western Pal.—73. *S. proximus* (Dhlb.). Chiefly its wing-cells variable. Presumably 2, E.—74. *S. sinuatus* (Hpt.). Euryök, perhaps stenök eremophil. From Elsass.—75. *S. differens* (Hpt.). In the Plains, Germany.—\*76. *S. implicatus* (Hpt.). 4 females have been collected. From Germany.—77. *S. contemptus* (Tourn.). Syn.: *Psammochares subarcuatus* Hpt, 1926—27, according to Beaumont 1946. Variable both in the position of ocelli and the size of the cubital cells. Presumably 2, M, Middle Europe and Holland.—78. *S. arcuatus* (Hpt.) 1c, from Italy.—79. *S. crassicornis* (Schuck.). May be 3, E.—80. *S. Sahlbergi* (Mor.). 2, E.

*Evagetes* Lep.—81. *Ev. dubius* (Lind.). Partly the extension of the red color of the abdomen and partly the position of ocelli vary. Venation, also, varies. Presumably 5, E.—

*Anoplus* Duf. A mostly hypereuryök intermediär species.—82. *An. samariensis* (Pall.). Typically 1b, coastal zones of the M.—83. *An. fuscus paganus* (Dhlb.). As *An. fuscus* (L.) is distributed in Northern Africa, and from Spain to the Caucasus,



Map. IV. Distribution of species with hypereuryök intermediär character:  
 ● *Ps. carbonaria* (5). (Orig.)

and as forma *paganus* spreads further north in the whole Europe and Finland, and Mongolia, it is manifest that we have to take *paganus* a subspecies. In specimens from Italy, Graece, and Turkey, where the distributional borders of the species and subspecies overlap, the red spot on the hind tibia is substantially smaller (♀). 5.—84. *An. infuscatus* (Lind.). Very characteristic in spite of its varying. 5, Pal.—85. *An. nigerimus* (Scop.). 5, E.—86. *An. concinnus* (Dhlb.). The females of this and of the next species are very difficult to distinguish. 5, Eastern Pal.—87. *An. piliventris* (F. Mor.). Baltic, presumably 3, known also from Siberia.—88. *An. atricolor* Móczár. Differs from other species by its short antennal segments (like in *nigerimus*), small stigma, not narrowed 3rd cubital cell. 3, endemic.

*Tachyaetes* Hpt.—89. *T. filicornis* (Tourn.). Mandibles on some older specimens strongly shortened (worn?) and terminate bluntly like in *Cr. affinis*, instead of the 2 sharp teeth. Ocelli form sometimes an acute-angle, sometimes a right-angle. 2, M. and Middle Europe.—90. *T. Dudichi* Móczár. Since the description of this species (1944) another specimen was collected. 1a, endemic.

*Anospilus* Hpt.—91. *Anosp. orbitalis* (Costa). Typically 1c (see map I), M. to Budapest.

*Telostegus* Costa.—92. *Tel. major* (Costa). I did not find males with genital plates as described by Haupt (1930), among the Hungarian specimens. Therefore I record males, otherwise conforming this description, with different genital plates. Haupt also defined the mentioned specimen as *Tel. major* (1943). 1c, M. and Moravian Basin.

*Episyrton* Schdt.—93. *Ep. rufipes* (L.). Typically 2, (see map II), Western Pal.—94. *Ep. rufipes* var. *tripunctatus* (Dhlb.). Well separable from other species owing to its color. Rarer.—95. *Ep. albonotatus* (Lind.). Rarer than *rufipes*, 2, Western Pal.

*Batazonus* Ashmead.—96. *B. lacerticida* (Pall.) 1c, M. and the Southern parts of Middle Europe.

*Dicyrtomellus* Guss.—97. *Dic. luctuosus* Mocs. 1c, tending to 2, together with former, as it ascends sporadically lower hilly regions, too. M.

*Pompiloides* Rad.—98. *Pomp. obtusus* Guss. The postnotum and shape of the cubital cells is variable. Typically 1a, Pontic, steppe inhabiting species. Southern Russia. (see map I).—99. *Pomp. sexmaculatus* (Spin.). Not only the form of the cubital cells are different on some specimens, but even the cubital cells of the right and left wings are not equal on a few. 1c, in the sand dunes to Finland, Western Pal.—\*100. *Pomp. sericeomaculatus* (Kohl). A very characteristic Pontic species, stenök eremophil, from the Near East and Southern Russia.

V. Subfam.: *Pedinaspinae* Haupt.—\**Pedinaspis* Kohl.—\*101. *Ped. crassitarsis* (Costa). Typically 1b, M.

*Aporus* Spin.—102. *A. tibialis* Tourn. Known from the Carpathian Basin on account of biographical data. In Middle Europe.—103. *A. inermis* Brullé, 1c, M.—104. *A. helveticus* (Tourn.). Rare collected in some localities in Transsylvania. Probably 2, M.—105. *A. femoralis* Lind. 3, M. and the Southern parts of Middle Europe.

VI. Subfam.: *Homonotinae* Hpt.—*Paraferreola* Sust.—106. *Par. manticata* (Pall.). Males difficult to separate from the next, ones. Among females occur transitional forms. There are specimens of *rhombica*, with a red spot on both sides of the pronotum. In all likelihood we are dealing with one species, only, 2, M.—107. *Par. rhombica* (Christ.). Known or one species and subspecies, apart from the M. also from the Southern part of the E.

*Arachnotheutes* Hpt.—108. *Ar. rufithorax* (Costa). Typically 1c. In Eastern and Southern Europe with the dispersional limits Budapest, Southern Switzerland.

*Platyderes* Guér.—109. *Pl. diffinis* (Lep.). Presumably 3, Western part of the Pal.

*Homonotus* Dhlb.—110. *H. sanguinolentus* (F.). Owing to the intensive variability it is very difficult to separate this species satisfactorily from the other two. 1c, Western Pal.—111. *H. Steini* (Schulz). Syn.: *H. laesus* Hpt. 1927 nec Mocsáry (Móczár 1946 b).—112. *H. balcanicus* Hpt. 1c, from Montenegro and Poros.

The Pompilid fauna of the Carpathian Basin may be said as rich, however, in spite of the great number of species, not thoroughly explored as yet. An account of the data at our disposal we have a very characteristic set-up regards both the dispersion of species and the components of our fauna. It was proved, indeed, that, in strict harmony with the oecologic factors, half of the species belong to the eremophil types, the stenök type having a great majority. Further besides the overpowering number of widely dispersed hypereuryök intermediär species, hylophil species taken only a small part in the composition of the Pompilid fauna. Accordingly, the structure of the Pompilid fauna in the Carpathian Basin—regarded from zoogeographical point of view—is based on Western Palearctic, Euro-turanian, Middleeuropean, and a minority of Palearctic species (half of the fauna in this case), modified by a conspicuously large number (30 p. c.) of Mediterranean, some Endemic and Pontic, and a few Balcanic, Atlantic and Baltic species, as coloring elements to the fauna.

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## SWARMING HABITS OF MOSQUITOES

By Erik Tetens Nielsen

The private laboratory "Pilehuset" is situated in North Sealand, Denmark; the surroundings are heather-moors with some birch wood. Earlier there has been some peat-digging, and there are now many temporary pools, which give a rich population of culicids; from the peat ditches and the near fresh water lake, Arresø, we get swarms of *Corethra* and chironomids.

In our laboratory we have been interested in the ecology of nocturnal insects and the large mosquito swarms observed at certain nights led us in 1938 to start investigating the swarming of mosquitoes.

In 1939 some results were obtained, but from 1940 we had to postpone the investigations on account of the German invasion of our country, which made it impossible for us to use strong projectors and other apparatus necessary for the observations.

After the war my friend, Hans Greve, joined me in this work, and our common studies are now so far advanced that we have finished a report of which I shall give an abstract today.

We have in our studies especially dealt with the swarming habits of the culicids, which very regularly form swarms in May or June. *Aedes cantans* is by far the dominating species although some other species are swarming too. We have found no differences between the culicide species in their swarming habits; the different types of swarms, which I shall describe later on, are not (as has often been assumed) characteristic for the species, but they are phases of the swarm made by all the species of culicids observed by us.

The swarms of *Corethra* are very nearly the same as the culicide swarms; the chironomids are a little different from the others, but only in details.

During the daytime we find the culicids everywhere in grass and other low vegetation in shady places. From time to time they are moving about a little, and they do this in such a way that they are never hit by the sun. Only the approach of a man or another big creature will bring them higher up than a few centimetres over the grass. Most of the copulations take place during the day.

When you walk through the grass during the day you will see the mosquitoes fly up already several metres in front of you. Some of the females will try to bite you, but when you are away the animals will soon return to the grass. Later in the afternoon, about 2—3 hours before sunset the mosquitoes disturbed by the observer will not immediately return to the grass, but the males will linger some time about 1—2 metre over the ground forming small swarms. We call such swarms *provoked swarms* because they are always formed by the passage of some creature. About one hour before sunset we have the first spontaneous swarms of the same type as the provoked; we call the *ground swarms* because they are always found just over the ground. Simultaneously with the ground swarms many single mosquitoes are flying higher up in the air both females and males. The females are going to the foliage in the tree-tops, and the males will start to form swarms. We have now a situation which we call the *ascent* during which some copulations may still occur. The following phases are exclusively formed by males, and copulations are very rare.

All the animals have the abdomen more or less swollen by a clear sweet fluid; it is obvious that they have had a meal just before the ascent. The food may be honey from flowers or mostly honey-dew which during the swarming period is produced in larger quantities by aphids.

Some of the males form *free swarms* between the trees; year after year we find them in the same places. They are first in a height of two to four metres above the ground, but during the evening they are moving upwards to six to eight metres.

Another type of swarm is seen over the treetops generally consisting of rather few individuals. They are transit swarms in which the single individuals are only swarming for a period of ten to fifteen minutes. From these top swarms the mosquitoes fly to the foliage of the tree tops where they stay during the night. The number of individuals in the top swarm is nearly constant during a period of between one and two hours so that the individuals flying away must all the time be replaced by others coming partly from the free swarms, and partly directly from the ground.

About half an hour after sunset the free swarms disappear and shortly after the topswarms diminish and gradually disappear about a quarter of an hour later. The mosquitoes are now practically all of them in the tree-tops, and there are only very few of them near the ground.

In the morning the swarms will appear again with the same types as in the evening, but in the reverse order: the morning swarms are symmetrical with the evening swarms with midnight as axis. The morning swarms, however, are generally not so distinct as the evening swarms, the whole picture is often blurred, and the phases sometimes shorter; in some cases there are no swarms at all in the morning. The same may happen, although only under very extraordinary conditions, in the evening.

The mosquitoes — males and females — descending to the ground in the morning are all without food in the abdomen; but soon after they have returned to the grass they are again swollen. The percentage of individuals with swollen abdomen decreases during the following hours and remains then constant and low until shortly before the ascent.

One of the most striking features in the swarming habits is the exact relations to the hour of the day; especially the disappearance of the topswarms may be predicted with an astonishing accuracy: We know now, for example, that on the third of June the topswarms will disappear at three minutes after half past nine ten minutes. The hours really found in the different years were: in 1939, when the weather was calm and cloudy, five minutes before half past nine; in 1940 thirteen minutes past on a very warm and beautiful evening; in 1945 the weather was a little windy and fresh, and the swarming stopped seven minutes past. In 1946 we had rain and a southwesterly gale of five Beaufort; the topswarms disappeared four minutes after half past nine. Finally in 1947 the swarming stopped already ten minutes before half past nine. The weather was cool with a fresh breeze from north-west.

With the purpose to get more precise information about the nature of the swarming habit we have tried to find correlations between the climatic factors and the hour of the day for the single phases of the swarming. We have found that the disappearance of the swarms in the evening is determined by a threshold in light intensity of about seven Lux measured by a luxmeter exposed to the diffuse light from the sky. In the morning the start of the swarms is at the same light intensity. The start of the swarms in the evening is influenced by the temperature: in cold weather the start of the

swarms is later than on warm evenings. It may also be expressed in stating that the duration of the swarming is shorter at low temperatures than at high. When the temperature is below ten degrees the duration may be as short as zero; there will be no swarms at all. With a climate as in Denmark this will sometimes occur especially in the morning.

Although the influence of temperature is obvious, the real factor releasing the swarming habit may be another one, which we have not yet found with certainty: but as far as we can see it is most likely that it is the change in light intensity which has the effect of inducing the swarming of mosquitoes. Experiments in the laboratory have shown that the general activity of culicids is governed by changes in the light intensity as well from high to low intensity as the reverse.

While the culicids are swarming in May or June, *Corethra* generally have their largest swarms in July, and the chironomids in August. With regard to the start and stop of the swarms they fit very well to the sunset and sunrise as in the culicids; even a late swarm of *Culex pipiens* in the last days in October showed the same relation to sunset, light intensity, and temperature as those of the other mosquitoes.

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## SEA-DRIFTS OF INSECTS AS A FACTOR IN DISPERSAL

By Ernst Palmén

Accumulations of sea-borne insects have often been observed on sea- and lake shores in several countries. The dispersal value of this drifting-phenomenon, however, has only been thoroughly studied in the last decade. In Finland, the well-known specialist on Diptera, R. Frey (1937), in a stimulating paper, called attention to the phenomenon. The investigations carried out by himself and some of his collaborators have recently been continued and completed by the author (Palmén 1944), mainly on the basis of observations and experiments made on the south coast of Finland, around the Zoological Station of Tvärminne. Some of the results obtained will be summarized here.

In the archipelago south- and westwards of the Hanko peninsula large accumulations of sea-borne insects are rather common and appear almost every summer. In 1935, 1937, and 1939 eight mass accumulations of drifted insects were observed. The general composition of these accumulations varies much, the orders *Coleoptera* and *Hemiptera* often predominating. However, sometimes *Diptera* and *Hymenoptera* (especially *Chalcidoidea*) may also occur in very great numbers. In certain cases the cast-up insect masses were composed of one single species occurring in very great numbers. On the eastern coast of lake Ladoga in 1942 the author observed an accumulation composed mainly of *Melasoma aenea* L. (*Chrysomelidae*); about 96,000 individuals of this species were present on each square metre just above the water level, the approximate number for a shore sector of 1 km being about 100 million specimens.

In estimating the dispersal value of the sea-drifts, the actual process of this phenomenon must be established as exactly as possible. The author has observed that almost all insect specimens found under such conditions were winged and thus capable of flying. Of species with wing dimorphism only the macropterous form was present. Therefore, the insects originally have been in flight and then been carried to the open sea by air currents or winds. Floods apparently had no significance in these cases, since even the most abundant and commonest Baltic sea-shore insects were almost completely lacking in the drift material. Thus the first phase of the phenomenon is anemochoric, and in a second phase the insects are driven by water-currents and thrown up on the shores.

After analyzing the beetle composition of the drift material some evidence can be given as to its origin. The material of three summers includes about 870 species, which is about one fifth of the whole number of Fennoscandian species. Among these there are at least 25 species which were previously not known to occur in Finland. Some of these species do not occur in Scandinavia either. They have without any doubt been carried from the area lying to the south of the Gulf of Finland. In one case, *Calosoma denticolle* Gebl. (*Carabidae*), a south-east European species, a transport distance of more than 1000 km is very probable. When one considers the covering of such a great distance as this, it appears that this means of dispersal may be a very important one.

As already pointed out, the drifting phenomenon is common on the south coast of Finland. The course of the meteorological conditions on the days prior to the appearance of the drift insects were in all eight cases mentioned rather similar. In all cases the

insects appeared in close connection with the passing of a weather front of a polar front cyclone (cf. P a l m é n op. c., p. 125). Since it has been suggested that electrical air phenomena occurring in connection with cyclones cause increased activity, as in birds, it might be possible to assume similar causes also for the increased flight activity of insects. This is, of course, as yet merely a hypothesis needing more investigation, especially much more factual material.

In most cases a great number of the insects found in drift accumulations on shores were alive. This was especially the case in regard to *Coleoptera*, *Hemiptera*, and hard chitinized forms of *Hymenoptera*, whilst less chitinized and frail *Diptera* were often drowned in the sea. To estimate the resistance of insects driven with the surface water some experiments with different kinds of water were carried out, namely with fresh water, brackish water from the Finnish Gulf (about 0.5 ‰ salts), and North Sea water containing about 3.1 ‰ of salts. The results of these experiments are summarized in Table 1.

	Survival time (days)		
	a	b	c
<i>Coleoptera</i> :			
<i>Loricera pilicornis</i> F. ....	> 5	> 5	> 5
<i>Dyschirius arenosus</i> Steph. ....	4	4	1 1/2
<i>Bembidion lampros</i> Hbst. ....	> 5	> 5	> 2 5
<i>B. obliquum</i> Sturm. ....	> 5	> 5	4
<i>B. transparens</i> Gebl. ....	> 5	> 5	3
<i>B. doris</i> Panz. ....	> 5	> 5	3
<i>Acupalpus dorsalis</i> F. ....	> 5	> 5	3
<i>Acidota crenata</i> F. ....	4 1/2	4	2 1/2
<i>Oxytelus rugosus</i> F. ....	> 5	> 5	3
<i>Philonthus varians</i> Payk. ....	> 5	> 5	4
<i>Rhagonycha limbata</i> Thoms. ....	2 1/2	2 1/2	1
<i>Cantharis figurata</i> Mannh. ....	2 1/2	2 1/2	1 1/2
<i>Coccinella hieroglyphica</i> L. ....	4	4	2 1/2
<i>C. 7-punctata</i> L. ....	> 5	> 5	3 1/2
<i>Limonium aeruginosus</i> Oliv. ....	1 1/2	1 1/2	1
<i>Athous subfuscus</i> Müll. ....	2	2	1 1/2
<i>Hylobius abietis</i> L. ....	> 5	> 5	> 5
<i>Hemiptera</i> :			
<i>Dolycoris baccarum</i> L. ....	> 5	> 5	< 2
<i>Elasmucha grisea</i> L. ....	> 5	> 5	< 1
<i>Elasmotethus interstinctus</i> L. ....	> 5	> 5	< 1

Table 1. Survival time of some *Coleoptera* and *Hemiptera* species floating on water surface (18—21° C). a. Saltfree water, b. brackish water (salt content about 0.5—0.6 ‰), c. sea water (salt content about 3.1 ‰). Adapted from P a l m é n 1944.

It was observed that most beetle species investigated easily survive 5 days floating on the surface of fresh and brackish water. This was the case in regard to species which possess hard elytrae and a hard chitinized abdomen, between which some air is retained. In this way air support may be secured when the animals are floating on the surface of the water and also when they occasionally become submerged. The air bubble then works like a physical gill and makes diffusion of oxygen from the water to the tracheae possible. Less chitinized forms, for example *Cantharis*, can not long maintain such an air supply, and therefore they probable die from lack of oxygen. This is also the case with Staphylinid beetles with very short elytrae.

In sea-water with high salt content the survival time of most species investigated was considerably shorter. Also in this case the species with a thin chitin cover were more sensitive than the thickly chitinized ones. This is probably due to the desiccating power of the salty water. However, even in the sea-water with the highest salt content all the species investigated well survived floating for about one day.

Drifting in sea-water seems not to cause any decrease in the reproductive activity of the insects. This may be judged from the fact that, after they have become dry, the cast-up insects can very often be observed copulating on dry shore-stones. But also experiments made with 6 beetle- and 1 *Hemiptera*-species seem to confirm this. The reproductive potential does not seem to suffer any damage from floating in sea-water for several days. If external conditions for survival are present, the insects therefore may be able to establish themselves in the area where they have been washed ashore.

For certain reasons the author is inclined to believe that the manner of dispersal dealt with may in certain respects be much more favourable than either pure anemochoric or pure hydrochoric dispersal. This may chiefly be due to the fact that insects material from wide areas is concentrated on rather small shore areas. Therefore, also in less abundant species, it will be fairly easy for the sexes to find each other and reproduce at the landing spot. If pure anemochoric dispersal is considered, the specimens will theoretically drop down on the earth more or less far from each other, and therefore the chances for reproduction will be smaller than in the former case. If the high reproductive activity of landed insects too is considered, this may appear very probable.

When relatively longer transport distances are considered, the hydrochoric concentrating phase appears more and more important, since the number of individuals carried by air currents will become smaller and smaller during the anemochoric process. Theoretically, in certain cases the final hydrochoric phase will be necessary for bringing together several individuals of certain species. Only parthenogenetic species will not be favoured by the final phase, since for them mere carrying of one single individual can be sufficient to enable colonization of a certain area. According to the author's observations, the female specimens of insects found in sea-drift seem not to have been fertilized; if this is in general the case, the final concentration phase may have fundamental importance.

In comparison with pure hydrochoric dispersal the combination form dealt with (anemohydrochoric dispersal) is in some cases clearly more favourable too. Dispersal by sea-currents proceeds relatively much more slowly, and therefore a very high survival value of the insects carried is necessary, if the transport distances are rather long. In the author's opinion, almost all hard chitinized beetle and Hemiptera species for instance, easily withstand a sea-drift of one or more days. This time, admittedly, is quite insufficient for long hydrochoric dispersal. Therefore, a preceding wind dispersal may make it possible for the insects to cover fairly great sea-distances, and the hydrochoric concentration of the specimens dropping in the sea may highly favour the establishment of bridge-heads in the place of arrival.

One of the chief dispersal problems for the Fennoscandian area is the estimation of the relative importance of different routes of immigration. Is the Baltic Sea with its gulfs really a barrier for expanding insects or not? Up to date, the author considers it almost certain that both the gulfs of the Baltic Sea are far too small to be effective barriers for flying insects. Several facts seem also to indicate that the whole basin of this sea is too small to be a real barrier. It is indeed evident that pure anemochoric

dispersal may have much smaller chances of resulting in establishing a bridge-head than a combined wind- and water-transport.

At present it may not be possible to give a general review of the probable significance of this mode of spread. However, some facts should be mentioned in this connection. Especially if transport distances are not very long and if the directions of sea-currents impede hydrochoric dispersal, this combination form may be a very important one. With regard to the gulfs of the Baltic Sea this may be the fact, since sea-currents generally do not flow straight across them but in a longitudinal direction. Similar relations may be present also in other areas. This mode of dispersal may be fairly important also in several other European areas, e.g. between England and the European mainland, between this area and the islands of the North Sea, and so on. Recent observations made by Hardy and Milne (1937, 1938) on insects flying over the North Sea confirm the reality of wind dispersal also in this area. In England, however, thorough analysis of the specific composition of insects masses driven ashore have not as yet been carried out. Therefore we do not know whether species not living regularly in this area have been present in such material.

The anemohydrochoric dispersal is perhaps mainly restricted to some particular insect groups. It may be very important for *Coleoptera* and *Hemiptera Heteroptera* occurring in most cases very abundantly in the drifted material, but representatives of the *Diptera*, for instance, may in most cases be too frail to withstand floating or, especially, submersion for some time. On the other hand, several wasps, especially representatives of the smallest ones, seem to withstand these conditions fairly well. As yet it is, indeed, not possible to draw any definite conclusions, since studies on coasts of oceans have not been carried out. It is to be hoped that some entomologists working in areas where this phenomenon could be studied will give it their attention.

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## OBSERVATIONS SUR LA FAUNE ENTOMOLOGIQUE DES NIDS DE PLOCEINAE

Par *Renaud Paulian*

Les Oiseaux Passériformes du groupe des *Ploceinae* édifient des nids remarquablement perfectionnés, à ouverture latérale. On peut y reconnaître deux types principaux :

Un nid en ovoïde plus ou moins régulier, avec une ouverture simple, située vers le haut de l'une des faces.

Un nid en cornue, l'ouverture de la cornue s'évasant vers le bas, et formé d'une fine dentelle tressée, en général, en fibres détachées des feuilles de Palmiers.

Ce second type, qui est figuré dans la plupart des ouvrages, sous le nom de nid de Tisserin, se rencontre en Afrique tropicale, sur la Côte Ouest de Madagascar et en Birmanie; il est construit, dans chacune de ces régions, par des espèces bien différentes.

Fréquemment, après avoir abrité une génération de Plocéines le nid est réutilisé par d'autres Oiseaux. C'est ainsi qu'à Madagascar, les nids de *Foudia sakalava minor* sont souvent habités par les *Spermestes nana*, autre Plocéide qui y bâtissent un vague abri en plumes. Il ne semble pas, pourtant, que ces hôtes secondaires modifient la composition de la faune entomologique des nids.

En effet, partout où ces nids ont été étudiés, ils ont livré riche moisson d'Insectes divers.

De Birmanie, Scott a signalé deux Corylophides, un Silvanide non déterminé et des chenilles.

Au Congo Belge, Ghesquière a découvert un Carabique spécial *Euplynes nidicola* Burg.

En Côte d'Ivoire, une étude détaillée nous a permis de relever la présence dans les nids, en dehors d'Acariens et d'Hyménoptères non encore déterminés, de 29 espèces d'Arthropodes, réparties comme suit : —

- Collemboles : 10 espèces;
- Blattes : larves indéterminables;
- Psocoptères : 8 espèces
- Hétéroptères : 1 espèce
- Coléoptères : 6 espèces (dont 2 Corylophides et 1 Silvanide)
- Lépidoptères : 1 espèce
- Diptères : 2 espèces.

A Madagascar, l'étude détaillée de quelques nids récoltés à Tuléar, juste après l'achèvement de l'élevage des jeunes, au début de ce que nous avons nommé la phase d'abandon, nous a fourni : —

Araignées : 6 espèces (*Scytodes*, Thériidiide sp. 1 et Salticide, en nombre; Thériidiide sp. 2, Argiopide et Clubionide, avec chacun un exemplaire).

Acariens : nombreux et indéterminés actuellement;

Collemboles : 1 espèce;

Blattes : très nombreuses larves indéterminables;

Psocoptères : nombreux, en au moins 2 espèces;

Hétéroptères : 2 espèces;

Coléoptères : 1 espèce (*Paulianites nidicola* Jeann., n. gen., n. sp.);



Lépidoptères : 1 espèce;  
Hyménoptères : 1 Braconide;  
Diptères : 2 puparia brisés.

Cette composition mérite certaines remarques.

- a. Tout d'abord, l'abondance des Araignées, toutes banales, est curieuse; elle doit se rapprocher de l'abondance d'Araignées d'un nid de Bihoreau, étudié à Tananarive.
- b. Les Blattes sont très nombreuses, et présentés dans tous les nids; peut être la présence de Blattes en Côte d'Ivoire, considérée par nous, alors, comme accidentelle, doit elle être rapprochée de la présence de Blattes à Tuléar, et s'agit-il d'espèces spéciales.
- c. Les nids de Tuléar n'ayant pas été étudiés par lavage, il est probable que beaucoup de Collembolles ont échappé aux recherches.
- d. Les chenilles de Lépidoptères, que nous n'avons pas réussi à élever, et qui sont sans doute parasitées par le Braconide, paraissent appartenir à un Tinéide, comme les chenilles élevées en Côte d'Ivoire.
- e. Les Hétéroptères sont apparentés au *Lyctocoris* de Côte d'Ivoire.
- f. Les nids de Tuléar n'ont fourni ni Silvanide, ni Corylophide; cela ne permet pas d'affirmer leur absence.

Si maintenant nous comparons entre elles, les faunules observées en Birmanie, au Congo, en Côte d'Ivoire et à Madagascar, en faisant la part des lacunes dues à l'inégale valeur des prospections effectuées, nous sommes obligés de reconnaître une étonnante autonomie à la faune des nids de *Ploceidae*.

Dans notre travail sur les nids de *Ploceidae* de Côte d'Ivoire nous insistions sur le double caractère d'homogénéité (constance, dans les divers nids, des espèces nidicoles) et d'autonomie (fidélité très grande de ces espèces aux nids de l'espèce étudiée) de leur peuplement. L'extension de nos recherches au *Foudia* de Madagascar vient renforcer et généraliser ces conclusions. En effet, tout d'abord, les espèces récoltées à Tuléar étaient, dans leur ensemble, constantes dans les douze nids — provenant de deux colonies différentes — étudiés. D'autre part ces espèces renferment des endémiques remarquables, tels le *Paulianites nidicola* Jeann., dont la fidélité est certaine.

Mais les choses vont plus loin que cela. Si nous considérons non plus les nids de telle ou telle espèce, mais les nids cruciformes des Plocéines de l'Ancien Monde, dans leur ensemble, ils nous montrent une faune sensiblement homogène et autonome. Le Carabique de Tuléar, répond à celui d'Eala au Congo; les chenilles de Tinéide, vivent en Birmanie, à Madagascar et en Côte d'Ivoire; les Corylophides et les Silvanides, en Birmanie et en Côte d'Ivoire; les Psocoptères, les Hétéroptères et les Blattes, à Tuléar et en Côte d'Ivoire. Naturellement, de même que les Plocéides eux mêmes appartiennent à des espèces différentes, de même les divers hôtes ne sont ni conspécifiques ni même, bien souvent, congénériques. Mais leur parenté systématique est bien réelle, et telle que l'autonomie des commensaux de Plocéides devient évidente. Le fait est d'autant plus remarquable, qu'il s'agit là d'un milieu, peu étendu, discontinu, instable.

Le problème est, en tous points, comparable à celui posé, à une toute autre échelle, par le concept du biome (Shelford).

En effet, cette faune des nids de Plocéides, n'a rien de commun avec la faune des nids d'autres Oiseaux. A Madagascar même, la comparaison de la faune de nids de Bihoreaux, de *Scopus umbretta* et de Plocéides est significative.

Nous donnerons ici la composition de deux nids de Bihoreaux comparée à celle de douze nids de Plocéides.

Nids de *Nycticorax*

Dermaptères : *Euborellia annulipes* Lucas, très abondant et *Thalperus ova* Borm., rare (espèces largement répandues).

Blattes : quelques larves

Acariens : nombreux

Hétéroptères : 4 espèces, dont un Réduvide et un Cimicide.

Coléoptères : 3 Staphylinides, 3 Clavicornes, 1 Coccinellide, 1 Hydrophylide.

Diptères : 1 Micromuscide

1 Calliphoride.

Nids de *Foudia*

Blattes : très nombreuses

Acariens : nombreux

Hétéroptères : 2 espèces de Mirides

Coléoptères : 1 Carabique

Diptères : 2 puparia de Muscides.

Collembolés : 1 espèce.

Psocoptères : nombreux, 2 espèces.

Lépidoptères : 1 espèce.

Hyménoptères : 1 espèce.

La composition faunistique, des nids de Bihoreaux, rappelle celle qui a été observée dans les nids d'autres Oiseaux en Europe et en Amérique du Nord; en particulier la présence de Staphylinides, de Clavicornes et de Cimicides, est tout à fait normale.

Les ressemblances entre les divers nids de Plocéines, ne tient donc pas à ce qu'il s'agit de nids d'Oiseaux; c'est une ressemblance due au caractère "plocéidien" de ces milieux, et non à leur caractère "avien".

D'autre part, le nid, même plocéidien, ne fonctionne pas simplement comme un filtre, prélevant certaines espèces seulement dans le milieu extérieur; dans chacune des régions considérées, certaines au moins des espèces inféodées aux nids de Plocéidiens sont propres à ces nids, et ne se retrouvent pas ailleurs. L'endémisme peut même atteindre l'échelon générique : *Ploceovanus* en Côte d'Ivoire, *Paulianites* à Madagascar; il atteint plus souvent l'échelon spécifique. Notons que même lorsqu'il atteint l'échelon générique, le genre endémique est apparenté à d'autres genres xénophiles. Le fait est évident pour les Silvanides; il se retrouve pour le genre *Paulianites* qui est très proche du genre *Oecornis* Britton (*Ent. monthl. Mag.*, LXXVI, 1940, p. 110) décrit des nids de *Bycanistes* (*Bucerotidae*) d'Afrique Orientale. Jeannel a décrit un *Oecornis* *Vadoni*, de Madagascar (Antongil); on n'en connaît pas la biologie. D'autre part le genre *Oecornis* est à peine différent du genre *Somotrichus* dont les espèces sont plus ou moins anthropophiles ou xénophiles (certaines pénètrent dans les grottes à la suite de leurs hôtes). On a donc là tout un groupe systématique à tendances biologiques identiques.

Ainsi on est amené à admettre que, dans des régions différentes, des hôtes différents ont créé des milieux suffisamment identiques pour que des faunules non seulement homogènes mais encore autonomes s'y développent. L'individualité de ces faunules revêt une importance toute particulière; elle prélude en quelque sorte à l'individualité des biomes et nous fournit un moyen d'étudier, à une petite échelle, les problèmes posés par l'autonomie des biomes.

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## A METHOD FOR EXPERIMENTAL STUDIES ON BATESIAN MIMICRY

By *Björn Petersen*

We speak about Batesian Mimicry, when a species of a group, often persecuted by different predators, shows resemblance not to its closest relatives but to one or perhaps some few species of a different group, which is not often preyed upon. This phenomenon was first discovered by Bates (1862) and got its name after him.

Bates gave an explanation too. He pointed out that the imitated forms, the models, were very little persecuted by enemies. It seemed probable to him that mimicking species could develop by the aid of natural selection, as specimens similar to the model would be more favoured than others.

The observations on mimicry in nature have increased since then, and we know now a great deal about it. The following characteristics of model and mimic are taken from Carpenter and Ford (1933). The models are abundant, brightly coloured, conspicuous (aposematic) species, sometimes with slow and heavy movements. They are often gregarious.

The mimics always occur in the same localities and at the same time as the models. They are less abundant than the latter. If the model varies geographically the mimic sometimes shows a similar variation. Cases are known where a mimic shows resemblance to different models in different parts of its area of distribution.

Morphological investigations have shown that mimicry has only changed the external appearance and behaviour so as to resemble the model, but not the anatomy. So it is unlikely that the habitat has produced the resemblance. "We are compelled to believe that mimicry is directed against the eye of a percipient enemy" (Carpenter l.c. p. 31).

Experimental investigations on mimicry were mainly made as feeding experiments. Attempts were made to find out which species are immune from attack by insectivorous animals, and which species gain protection by resembling them. For references see Mühlmann 1934, Cott 1940, and Heikertinger 1939, 1942. In these experiments insects were usually given to an insect eating animal in a cage. If an insect is not taken it is said to be protected and vice versa.

Another method for investigating protection is by examining stomach-contents of birds. The results of such investigations are often contradictory to the others, and have often been interpreted in different ways by those arguing for or against the theory of mimicry.

Very often the investigator starts with the idea that protection must reach 100% to prove the possibility of mimicry. And even if it is admitted that a 100% protection is not needed (as e.g. by Heikertinger 1942 p. 348), in the subsequent argument this is ignored.

The problem we deal with can be formulated briefly as follows: Is a certain species or group of species (A) somehow protected against its enemies, or at least some of them, to such an extent that differences in similarity to A in another species B can cause differences in protection large enough to produce an evolutionary change in B?

It seems to me impossible to attack this problem by investigating stomach-contents of birds without any comparison with the fauna from which the birds feed. Even experiments of the usual sort seem to show very little. I wish especially to point

out that the impossibility of mimicry cannot be proved in that way, as a protection of only a few percent is enough to give an evolutionary change. The existence of such small differences can hardly be disproved by such experiments, because of the impossibility of reducing sufficiently the sources of error.

I think that some sort of model experiment would be the best way to increase our knowledge of how selection can work to effect mimicry.

In 1934 M ü h l m a n n tried to find a suitable experimental method for studying mimicry. He used in his experiments as models larvae of the mealworm *Tenebrio molitor*, which he coloured red. As colouring matter he used raspberry-red, but cellulose-red which stays on the cuticle better can be used as well as some preliminary experiments of mine have shown. I found that a crow did not discriminate between uncoloured mealworms and such with two red segments.

To the red colour of the models M ü h l m a n n added some distasteful substance such as salt, quinine, magnesium sulphate, soda and saccharin before he finally decided to use potassium antimonyl tartrate. The poisoned mealworms were regurgitated by the birds a few minutes after being eaten. Some minutes or hours later the birds in most cases ate as usual.

In this way M ü h l m a n n succeeded in getting a model which was eaten only a few times before the bird had learnt not to take it. The models were in his experiments after the learning period unpoisoned.

M. used models coloured all over and mimics with 1, 2, 3 etc. segments uncoloured. These were in his series of experiments placed either in the middle or the outer parts of the worms.

M.'s main object (l.c. p. 260—261) was to find out how similar to the model a mimic has to be to get any protection from it and how far the mimic can depart from the model without losing its protection.

In each experiment he used only a few specimens, usually one model and one mimic. The experiments were made so that the model was given to a bird together with the mimic which was most or least similar to the model. If the last was not taken the experiment was repeated with the next number of the series and so on until the mimic was eaten. At that point of the series selection was supposed to start.

To put the question in this way is quite wrong, however. It is not possible to find a special stage where selection starts. Cf. e.g. a parallel example in Fisher (1930 p. 15) where the frequency with which test objects of different weights are judged heavier than a standard 100 gram weight is plotted against the different weights.

Even if the investigation made by M ü h l m a n n was founded on a wrong assumption, his method, somewhat altered, seems to me rather useful for further research. In every experiment there have to be a models, b mimics, and c unpainted worms used as standards, where a, b, and c represent the number of the different types. The models must be very weakly poisoned so that the birds can go on eating even if a model should be eaten.

The experiment may be broken when e.g.  $\frac{b+c}{2}$  worms have been eaten, but can of course be repeated many times.

As the similarity of model and mimic in nature does not lie in the colour of the whole animal but more in the colour and shape of different parts, a model ought to be used with only a few coloured segments. The relative extent of the coloured area in the mimics can then be varied in different experiments (cf. fig. 1).

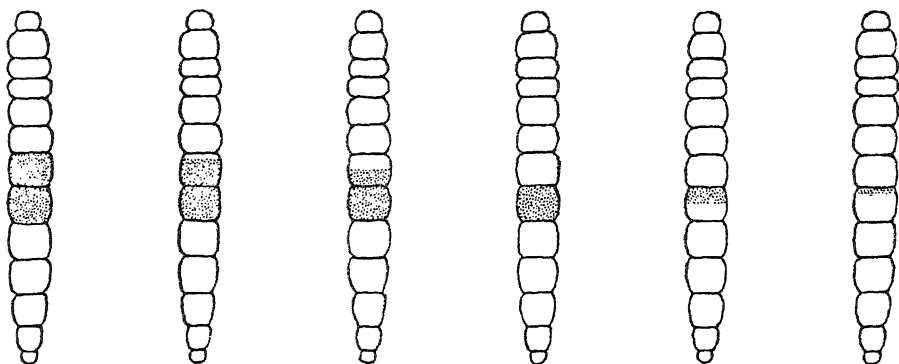


Fig. 1. Model (to the left) and mimics with 90%, 75%, 50%, 25%, and 10% of the coloured area of the model. Red areas dotted (cf. the text).

The selective advantage of the differently coloured mimics over the uncoloured standard can then easily be calculated and plotted on a diagram. One can also study the possible disadvantage caused to the model when it is associated with different mimics compared with when it is associated only with the standard, as well as many other points, such as differences in form, colour, position of the mark, size of model and mimic, etc. Some of these problems have already been studied by M ü h l m a n n and others.

As was pointed out by M ü h l m a n n, it is of course not possible to draw any conclusions directly from the results of such an investigation about conditions in nature. But it will perhaps be possible in the future to make similar experiments under more natural conditions, using natural models, mimics, and standards. This will of course be the best method of conducting investigations of this sort.

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## LES Curculionidae Cossoninae (Col.) ET L'INFLUENCE MARITIME

Par P. de Peyerimhoff

Le Catalogue mondial des *Curculionidae Cossoninae* (Col. Catalogus ed. Junk, pars 149, auct. E. Csiki 1936), — déduction faite de la tribu *Acamptini* transférée aux *Cryptorrhynchinae* (l. c., pars 151, p. 4) et du genre *Gryporrhynchus* qui appartient aux *Tychiinae* (sec. G. Marshall, *Proc. R. ent. Soc. London*, 1937, p. 58), — énumère 257 genres et un peu plus de 1.200 espèces. Ces insectes s'étendent sur le globe depuis le 70° L. N. (*Eremotes ater* en Laponie) jusqu'au 42° L. S. (*Micropentarthrum Sancti Pauli*, de l'île Saint Paul). On voit, en effet (R. Jeannel, *Croisière du Bougainville*, p. 12), que la vie dans l'Antarctide, à cause de la glaciation continentale, s'arrête bien plus loin du pôle (au 55° L. S.) que dans l'hémisphère Nord.

Dès la première lecture, deux constatations apparaissent : Ce groupe de Coléoptères, peu représenté dans l'hémisphère Nord ou, plus exactement, en Holarctide, domine dans les régions tropicales et australes, — et il pullule dans les îles, les presqu'îles ou les isthmes, tandis qu'il se raréfie fortement sur les continents. Les chiffres vont le préciser tout en dégageant des séries ou des détails parfois très instructifs.

### I — RÉPARTITION PAR RÉGIONS.

Presque chaque région du globe contient des genres endémiques, avec leurs contingents spécifiques, entremêlés d'un certain nombre de genres diversement partagés avec d'autres secteurs et donnant des espèces elles-mêmes endémiques qui s'ajoutent aux précédentes. Voici le décompte de ces éléments chez les *Cossoninae*.

Régions et Secteurs		Genres endémiques (et g. partagés)	Espèces endémiques
EUROPE	Euroméditerranée (+ 3 esp. sahariennes)	5 (11)	71 63
	Atlantides (Cap Vert excl.)	4 (8)	61 41
		9	104
ASIE	Asie septentrionale	0 (4)	0 6
	Asie tropicale	3 (14)	31 38
	Japon	9 (9)	13 24
		12	68
AFRIQUE	Afr. continentale (avec Cap Vert)	20 (10)	50 111
	Archipel malgache	19 (12)	24 90
	Sainte Hélène	15 (1)	54 55
		54	256

Régions et Secteurs		Genres endémiques (et g. partagés)	Espèces endémiques	
AMERIQUES	Amér. du Nord	12	18	289
	Amér. centrale	8	40	
	Amér. du Sud	12	128	
	Panamérique	11	12	
		43	79	
OCEAN INDIEN et PACIFIQUE	Malaisie insulaire Pacifique	13	17	262
	Mal. + Pacif.	23	102	
		7	19	
		43	124	
ENSEMBLE AUSTRAL	Australie et ses Iles	13	16	229
	Nouvelle Zélande et ses Iles	(13)	47	
	Antarctide	39	103	
		(11)	61	
		1	1	
		53	164	
Totaux:		214 genres endémiques	1208	
plus		43 g. partagés	espèces	
Total		257	endémiques	

## II — OPPOSITION DE LA HOLARCTIDE

*vis-à-vis des régions tropicales et australes*

Le tableau qui suit déplace les secteurs holarctiques pour les grouper, et préciser numériquement la diminution très marquée des *Cossoninae* dans l'hémisphère Nord.

Région holarctique	RSégions tropicales et australes
Euroméditerranée: 5 g. (+ 11) et 63 esp.	Asie chaude: .. 3 g. (+ 14) et 38 esp.
Atlantides: ..... 4 » ( 8 ) » 41 »	Afrique ..... 54 » ( 23 ) » 256 » (Berbérie ex- clue) et îles
Asie septentr.le: 0 » ( 4 ) » 6 »	Amér. centr. et
Japon ..... 9 » ( 9 ) » 24 »	Amér. du Sud .. 31 » ( 33 ) » 231 »
Amér. du Nord: 12 » ( 10 ) » 58 »	Malaisie et
30	Pacifique ..... 43 » ( 26 ) » 262 »
192	Ensemble austral 53 » ( 25 ) » 229 »
	184
	1016
	Total répété: genres 30 + 184 endémiques } 257
	43 partagés
	espèces: 192 + 1016 = 1208

Ainsi, dans la période actuelle, les *Cossoninae* des régions tropicales et australes ont six fois plus de genres et cinq fois plus d'espèces endémiques que la Holarctide. Cette disproportion, d'ailleurs, n'a rien d'insolite et on la constate dans bien des familles de Coléoptères. Surtout, comme le démontre une analyse taxonomique sommaire, elle n'exclut en rien la persistance, au Nord, de lignées très primitives : les *Cossoninae* se partagent en deux tribus, *Trypetini* (17 genres, en Australie, Nouvelle Zélande, Amérique centrale et du Sud, Afrique centrale, archipel malgache et îles du Pacifique), — et *Cossonini*, comprenant 9 sous-tribus :

*Apheli* (3 g.), en Nouvelle Zélande et Australie, *Dryophthori* (10 g.), mondiaux, *Pentarthri* (79 g.), mondiaux, *Onycholipi* (3 g.), Atlantides et Amér. du N. et du S., *Pseudapotropi* (1 g.), Amér. centrale, *Lymani* (2 g.), Amér. du N. et du S., *Cossoni* (113 g.), mondiaux, *Rhyncoli* (26 g.), mondiaux, *Hormopi* (1 g.), Amér. du N. De ces 9 sous-tribus, la Holarctide en possède 7, son secteur américain a l'un des deux genres (*Lymanthes*) des *Lymani* et, à lui seul, conserve le genre *Hormops*, des *Hormopi*<sup>1</sup>.

En réalité, c'est seulement l'Asie continentale où la déficience des *Cossoninae* est extraordinaire : l'Asie tropicale (les îles et presqu'îles exclues) n'a que 3 genres et 38 espèces endémiques, alors que dans tous les autres compartiments, ces chiffres vont respectivement de 18 à 50 et de 130 à 290. Quant à l'Asie tempérée et froide, ces insectes, qui dans le reste de la Holarctide sont exclusivement lignivores, n'existent dans l'immense taïga eurosibérienne que tout à fait à l'Ouest, en Russie et en Fennoscandinavie, avec deux espèces seulement, *Eremotes elongatus* et *E. ater*, attachées aux bois résineux. Les *Cossoninae* n'ont même pas atteint les forêts de *Picea* du Tian-Shan et, autant qu'on sait, sont à peine représentées (des *Eremotes* également) dans l'Himalaya et au Sikkim.

En somme, pour la Holarctide, la disproportion, si forte qu'elle apparaisse dans le nombre des genres et des espèces, s'atténue assez notablement quand on considère les lignées ou les superlignées.

### III — REPARTITION D'APRES LA SURFACE DES TERRITOIRES :

*Opposition des continents vis-à-vis des isthmes, des presqu'îles et des îles.*

Continents,		Isthmes et Presqu'îles	
Amérique du Nord: ....	9 g. endém. et 15 esp. } (10 g. part.) 37 » }	Amérique du Nord	
Amérique du Sud: .....	10 g. endém. et 10 » } (10) » 51 » }	Californie: ....	2 g. endém. et 2 esp. }
Afrique: .....	19 g. endém. et 48 » } (9) » 57 » }	Floride: .....	1 » » » 1 » }
Euromédi- -terranée: ....	5 g. endém. et 8 » } (10) » 35 » }	(2 g. part. avec les îles)	» 15 » }
Asie: .....	2 g. endém. et 2 » } (12) » 26 » }	Amérique: ....	0 g. endém. et 0 » }
Australie: ....	9 g. endém. et 9 » } (14) » 38 » }	Centrale: .....	(19) » 87 » }
	54	Asie (tropicale): ....	0 g. endém. » 0 » }
	336	(3) » 4 » }	4
		Australie	
		Cap York: (5)	» 7 » ) 7
		Îles (voir le tableau I)	
		200 (+8)	756
		203	872

<sup>1</sup> L'Amérique du Nord possède en outre une espèce du genre (américain) *Nanus* (*Trypetini*) commune à la Floride, au Mexique et aux Antilles. Mais l'importation, si fréquente, comme on le verra, chez les *Cossoninae*, ne permet guère d'en faire état dans la faune néarctique.



Ainsi, dans la période actuelle, les Cossoninae insulaires et péninsulaires ont presque quatre fois plus de genres et d'espèces endémiques que les continentaux. C'est la singularité marquante du groupe. Elle s'accroîtrait encore si on pouvait dénombrer les genres ou espèces localisés sur les continents au voisinage immédiat de la mer. Par exemple, sur les quelque 30 Cossoninae de la France continentale, au moins 4 espèces, *Caulotrumpis aeneopicea*, *Pentarthrum Huttoni*, *Eremotes filum*, *Mesites aquitanus*, ne s'éloignent pas (sauf importation accidentelle) de la zone littorale. Les Cossoninae semblent donc favorisés par l'influence maritime (voir infra § IX et X).

#### IV — LES GENRES PARTAGÉS

Les genres de Cossoninae présents à la fois dans deux ou plusieurs régions ou secteurs, et qui par conséquent n'ont pas le caractère endémique, sont au nombre de 43.

Trois sont virtuellement ubiquistes :

*Pentarthrum* (66 espèces) depuis les côtes N. O. de l'Europe jusqu'à la Nouvelle Zélande, à l'Australie, à la Tasmanie et à l'Antarctide (Ile Inaccessible, vers le 40° L. S.).

*Cossonus* (200 espèces) et *Rhyncolus* (83) de même, sauf qu'ils manquent à la Nouvelle Zélande. Ces deux genres sont presque également partagés entre les continents d'une part, les isthmes, presque îles et îles d'autre part.

Tous les autres genres occupent des aires plus ou moins limitées. Certaines de ces aires sont encore largement étendues :

*Dryophthorus* (37): Europe, Amér. du N. et Am. centr. archipel malgache, Ceylan, Nlle Guinée, Pacifique, Nlle Calédonie, Samoa, Hawaï. Il n'y a que deux espèces continentales.

*Eremotes* (27): Europe, Atlantides, Indes Britann., Afrique, Madagascar.

*Stenotrumpis* (26): Amérique et Antilles, archipel malgache, Pacifique, Nlle Zélande.

*Phloeophagosoma* (26): Australie, Malaisie, Japon, Séchelles, Nlle Zélande.

*Himatium* (14): Amér. du N. et Am. Centr., Afrique, archipel malgache, Assam, Java.

*Eutornus* (18): Indes, Ceylan, Birmanie, Philippines, Nlle Zélande.

*Stereoderus* (11): Australie, Pacifique, Azzam.

*Heterophasis* (6): Birmanie, Java, Nlle Guinée, Afrique du Sud.

*Pselactus* (8): Europe, Amér. du N., Canaries, Nlle Zélande.

*Stenoscelis* (4): Amér. du N., Japon, Afrique du Sud.

*Choerorhinus* (4): Europe, Japon, Afrique.

Mais le plus grand nombre se partagent entre deux régions ou secteurs seulement :

##### a) genres occupant des secteurs relativement voisins:

— Nouvelle Zélande et Pacifique: *Sericotrogus* (5),

*Microtribus* (4)

— Notiosoma (7), Isotrogus (2), Homalotrogus (2), Aphaenocorynus hmdleutaoshrdlui

— Australie, Malaisie et Pacifique: *Sterioborus* (7), *Notiosoma* (7), *Isotrogus* (2), *Homalotrogus* (2), *Aphaenocorynus* (7), *Microcossonus* (2),

— Pacifique et Asie tropicale: *Stercotribus* (4), *Conarthrus* (4).

— Euroméditerranée, Atlantides et Amérique du N.: *Mesites* (18). Deux autres "Mesites" ont été décrits anciennement de Ceylan et ne semblent pas avoir été retrouvés. Leur attribution générique laisse des doutes.

— Canaries et Cap Vert: *Pentatemnus* (2).

##### b) genres très disloqués

— Région australo-pacifique et archipel malgache: *Proëces* (8), *Orthotemnus* (3), *Coptus* (3).

— Indomalaisie et Afrique: *Hyponotus* (2).

— Pacifique et Afrique: *Leptomimus* (3). Mais les deux espèces décrites du Kenya appartiennent-elles réellement à ce genre?

— Pacifique et Japon: *Tetratemnus* (2), *Pseudocossonus* (3), *Tychiodes* (2).

— Indes et Japon: *Macrorhyncholus* (2), *Xenopus* (2).

— Amérique et Nlle Zélande: *Rhinasinus* (2), *Torostoma* (2).

- Amérique et Indomalaisie + Pacifique: *Dendroctonomorphus* (4), *Catolethrus* (14), *Stenommatius* (3).
- Amérique du Nord et Hawaï: *Macrancyclus* (2). Il est bien probable qu'il s'agit d'une importation en provenance de l'archipel.

Beaucoup de ces partages, analogues à ceux que l'on constate dans d'autres groupes, sont parfaitement normaux :

*Pentatennus* est un témoin de l'ancienne communauté des faunes dans l'ensemble des archipels atlantiques, aujourd'hui bien effacée par la différence des climats entre les Canaries et les îles du Cap Vert.

*Mesites* est un élément holarctique appartenant à l'ancien continent euro-américain.

Les rapports, entre Australie et Pacifique sont banals, ainsi que ceux qui se manifestent entre le Pacifique et l'Asie chaude.

Il est bien connu que le Japon possède, à côté d'éléments holarctiques, de nombreuses lignées malaises, ou indomalaïses, ou indo-pacifiques.

Les genres communs à la Nlle Zélande et aux Amériques sont fréquents dans les deux règnes, à cause de la continuité qui a longtemps persisté entre les axes montagneux des deux régions.

Le partage des *Proëces*, des *Orthotennus* et des *Coptus* entre la région australo-pacifique et les archipels malgaches, s'explique si l'on reporte Madagascar (avec ses îles) à l'époque où elle se rattachait à l'Inde, par conséquent à l'Extrême-Orient, lui-même imprégné d'éléments australopacifiques.

Les dislocations notées entre la région indomalaise et pacifique d'une part, l'Afrique ou l'Amérique d'autre part, sont plus mystérieuses. Elles apparaissent d'ailleurs dans bien des séries zoologiques.

Rien ici n'est donc particulier aux *Cossoninae*, et les problèmes relatifs à la diffusion des lignées restent posés pour eux comme pour les autres groupes.

## V — L'ENDÉMICITÉ DANS LES ÎLES

C'est dans ce qui suit qu'on trouvera les faits les plus remarquables relevés dans la statistique des distributions.

### 1<sup>o</sup>) Secteurs holarctiques.

Les Atlantides du Nord ont 4 genres de *Cossoninae* strictement endémiques et 7 genres partagés, totalisant 35 espèces endémiques. Si on en rapproche les îles du Cap Vert, comme le suggère l'affinité des *Cossoninae* dans l'ensemble de ces archipels, on compte 6 genres endémiques et 6 genres partagés donnant au total 39 espèces endémiques.

L'archipel nippon a 9 genres endémiques et 9 genres partagés, avec un total de 24 espèces endémiques. Ici les lignées sont plus nombreuses, tandis que les espèces le sont bien moins.

Ces deux compartiments sont aussi différents que possible : Les Atlantides ont des affinités euro-africaines, avec des éléments holarctiques (ex. *Mesites*), — les îles japonaises, comme on l'a noté plus haut, ont des affinités surtout indomalaïses.

On remarquera que les îles méditerranéennes n'ont aucun genre endémique, ni même (sauf Rhodes qui a un *Mesites* spécial), aucune espèce endémique. Les péninsules ibérique, italienne et balcanique sont tout aussi dépourvues.

### 2<sup>o</sup>) Secteurs américains —

Les Antilles, avec 45 espèces endémiques, n'ont aucune lignée qui leur soit propre. Mais elles ont 11 genres communs avec l'Amérique centrale, dont *Stenocylus* qui n'existe pas ailleurs, et 4 genres panaméricains. Leur faune est donc parfaitement américaine.

Les Galapagos et Juan Fernandez ont chacune un genre endémique, unispécifique, et les dernières un *Caulophilus*, genre américain.

3°) *Secteur malgache* —

Madagascar a 6 genres endémiques et 10 genres partagés, totalisant 39 espèces endémiques, — les Séchelles 12 g. endémiques et 10 g. partagés avec 46 esp. endémiques. Madagascar et les Séchelles se partagent le seul g. *Melarhinus* (2 esp.) et ont ensemble, avec Nossibé et Mayotte, une espèce d'*Orthotemnus*. Des 5 autres genres présents de part et d'autre, l'un, *Proëces*, existe dans la région pacifique, les 4 autres sont largement diffus. — Les Mascareignes, les Comores, Réunion, possèdent 5 esp. endémiques appartenant à deux genres ubiquistes, *Pentarthrum* et *Cossonus*, eux-mêmes représentés à Madagascar. — Le secteur réunit en somme 19 genres et 92 espèces endémiques, et la collection des Séchelles est sensiblement plus riche et plus variée que celle de la Grande Ile.

Sauf *Himatinum* (avec 14 espèces, dont 3 en Afrique, 2 à Madagascar, 3 aux Séchelles, 2 en Amérique, 2 aux Indes et en Assam, 2 à Java), les rapports entre les *Cossoninae* africains et malgaches sont nuls et, ainsi qu'on l'a indiqué plus haut, les affinités de ce secteur sont avec l'Extrême-Orient et le Pacifique.

4°) *Sainte Hélène*.

La concentration des *Cossoninae* à Sainte Hélène est prodigieuse : 15 genres et 54 espèces endémiques, plus un seul *Pentarthrum*. Or l'île est minuscule : 47 milles carrés, ce qui représente la surface de Paris<sup>2</sup>. On y connaît encore au moins 60 autres Coléoptères endémiques, dont le plus célèbre est le Calosome *Haplothorax Burchelli*.

Ascension, encore plus petite (34 milles carrés), et dont Wollaston notait, en 1861, la pauvreté sans égale dans le monde, n'a que le seul *Pentarthrum cylindricum*, d'origine américaine, importé d'ailleurs aussi en Malaisie et en Polynésie.

5°) *Secteur hindou*.

Ceylan, en fait de *Cossoninae*, n'a pas une lignée qui lui soit propre et on n'y compte que 9 espèces endémiques, appartenant à 5 genres diffus, sauf *Macrorhyncholus* partagé, avec le Japon. Elle participe à la pauvreté et à la banalité de l'Asie chaude.

Les Laquedives, les Maldives et les Tchagos sont des archipels coralliens maigrement peuplés et où le groupe traité ici n'existe même pas.

6°) *Secteur malais*.

Les îles de la Sonde, Sumatra, Java, Bornéo, Timor, etc., comptent 8 genres et 30 espèces endémiques, — les Philippines et les Célèbes 2 genres et 9 espèces, — au total 10 genres et 39 espèces. Le partage des genres non endémiques est naturellement fréquent avec la longue péninsule birmane.

7°) *Secteurs pacifiques (Mélanésie et Polynésie)*.

Moluques : 2 genres endémiques (plus 4 genres partagés) avec 6 espèces endémiques ; un genre strictement partagé avec la Nlle Guinée.

Sula : 1 (+ 2) genres et 3 espèces.

Nlle Guinée, Aru et Waigiu : 9 (+ 20) genres et 52 espèces; quatre genres strictement partagés avec l'Australie continentale.

Salomon : 1 (+ 00) g. et une esp.

Nlle Calédonie : 0 (+ 4) g. et 9 esp.

Fiji, Tonga, Ferguson : 0 (+ 2) g. et 4 esp.

<sup>2</sup> "Sainte Hélène, de 7 à 8 lieues de tour, environ la grandeur de Paris" (Cte de Las Cases, Mémorial, éd. de Bruxelles 1822, t. 2, p. 95)

Samoa et Christmas : 4 (+ 14) g. et 26 esp., 2 genres strictement partagés avec l'Australie continentale et 2 avec la Nlle Zélande.

Tahiti : 0 (+ 4) g. et 4 esp.

Marquises : 0 (+ 1) g. et 1 esp.

Les secteurs 6 et 7, géographiquement voisins, ont en commun les genres *Ochronanus* (Java et Nlle Guinée), *Pholidonotus* (Bornéo et Nlle Guinée), *Aphyoda* (Philippine et Nlle Guinée), *Oxydama* (Sumatra, Samoa et Nlle Guinée).

Rassemblés, ils totalisent 32 genres endémiques (plus 26 g. partagés) et 142 espèces endémiques.

#### 8°) Les Hawaï.

Cet archipel possède 9 genres (plus 6 partagés) et 103 espèces endémiques. Le genre hawaïen *Oodemas*, à lui seul, compte 57 espèces, et les *Dryophthorus* 18 espèces. *Macrancylus* est peut-être importé en Amérique du Nord, — *Sericotrogus* (5), genre néo-zélandais, a une espèce hawaïenne, — les trois autres genres partagés ont une répartition diffuse.

#### 9°) Secteur australien.

La Tasmanie a 1 genre (plus 3 part.) et 9 espèces endémiques. Elle partage strictement avec l'Australie le g. *Pentamimus*. — Lord Howe a 2 g. dont l'un, *Hoplocossonus*, est strictement partagé avec l'Australie, et l'autre, *Aphanocorynes*, avec l'Australie et les Samoa, — Norfolk a un *Pentarthrum* endémique. — King a le genre endémique *Conlonia*, unispécifique.

#### 10°) Secteurs néo-zélandais et antarctique.

La Nouvelle Zélande réunit 40 genres exclusifs avec 104 espèces, plus 10 genres partagés avec 60 espèces, au total 40 g. et 164 esp. de *Cossoninae* endémiques, — d'ailleurs que les secteurs malais et pacifiques ensemble (32 g. et 142 esp.). — *Aphela* (4) est strictement partagé avec l'Australie, *Sericotrogus* (5) avec les Hawaï, *Microtribus* (4) avec les Samoa, *Rhinasinus* (21) avec les Amériques. Les cinq autres genres partagés, *Stenotrupis*, *Stenomimus*, *Eutornus*, *Pselactus*, *Pentarthrum*, sont très diffus. *Dryophthorus*, *Cossonus* et *Rhyncolus* font défaut.

Les îles Pitt ont 2 *Pentarthrum*.

Inaccessible a un *Pentarthrum*, et l'île Saint Paul, située au 42° L.S., le genre endémique *Micropentarthrum*, unispécifique.

Cette endémicité insulaire, on le voit, est très inégale. Extrêmement marquée à Ste Hélène, dans les Séchelles, aux Hawaï, en Nouvelle Zélande, encore forte aux Atlantides, à Madagascar, en Malaisie, en Nlle Guinée, aux Samoa, au Japon, elle s'atténue beaucoup aux Antilles, dans le reste du secteur malgache, dans la plupart des archipels pacifiques et dans les îles voisines de l'Australie. Elle est très inégale aussi dans la densité à la surface. Si l'on choisit comme unité la plus petite île, Ste Hélène (47 milles carrés), les autres aires, rapportées à cette unité, se traduisent par les chiffres suivants<sup>3</sup> :

Sainte Hélène: .....	1	Antilles: environ .....	1270
Séchelles: moins de .....	3	Nouvelle Guinée: .....	1770
Samoa: environ .....	30	Nouvelle Zélande: .....	2073
Atlantides: .....	110	Japon: .....	2953
Hawai: .....	134	Madagascar: .....	4560

<sup>3</sup> Voici, pour les continents, quelques chiffres rapportés à la même unité (Ste Hélène) et qui donnent des ordres de grandeur: Afrique: 230.290, — Amérique du Sud: 137.080, — Australie: 59.280.

Ici encore, ce sont les petites îles, les petits archipels qui, en général, se montrent le plus peuplés. Ste Hélène est exemplaire à cet égard, les Séchelles aussi, à un degré bien moindre. Il faut cependant tenir compte de l'insuffisance des recherches, par exemple aux Mascareignes, aux Adaman et Nicobar, aux Nouvelles Hébrides, aux Carolines, aux Marquises, aux Kermadec, à Chatam de la région néo-zélandaise, etc., même aux Samoa dont l'exploration est loin d'être complète, — sans parler des îles coralliennes, Laquedives et Maldives, Amirantes, Bermudes, archipel des Marshall . . . où la faune est naturellement parcimonieuse, comme elle l'est à Ascension et à Tristan da Cunha qui, malgré leur position en latitude, sont tout aussi déshéritées. Les indications fournies sont donc provisoires, bien que le nombre et la qualité endémique restent et resteront toujours, pour le groupe envisagé, le privilège de certains territoires maritimes de faible étendue.

L'endémicité doit être appréciée, non seulement sur le nombre des genres et des espèces, mais sur leur classement taxonomique, ou, plus explicitement, en tenant compte des catégories supérieures (superlignées) auxquelles appartiennent ces éléments.

Voici ce classement, d'abord pour les régions continentales à titre de comparaison (l'Asie exclue à cause de sa pauvreté et de sa banalité), — puis pour les principaux secteurs insulaires.

#### *Régions continentales*

Euroméditerranée, 5 genres endémiques: *Cossini* (5),  
Amérique du Nord (4), 9: *Pentarthri* (1), *Onycholipi* (1); *Lymanti* (1), *Cossoni* (2),  
*Rhyncoli* (3), *Hormopi* (1).

Amérique du Sud, 10: *Dryophthori*, *Onycholipi* (1), *Lymanti* (1), *Cossoni* (5), *Rhyncoli* (2).

Afrique, 19: *Trypetini* (1), *Pentarthri* (3), *Cossoni* (12), *Rhyncoli* (3).

Australie, 9: *Trypetini* (1), *Apheli* (2), *Pentarthri* (4), *Cossoni* (2),

#### *Secteurs insulaires*

Atlantides, 6 genres endémiques: *Pentarthri* (1), *Onycholipi* (1), *Cossoni* (4).

Japon, 9: *Pentarthri* (1), *Cossoni* (-6), *Rhyncoli* (2).

Antilles (pas de genres endémiques)

Madagascar, 6: *Trypetini* (3), *Pentarthri* (1), *Cossoni* (2).

Séchelles, 12: *Trypetini* (3), *Pentarthri* (6), *Cossoni* (3), plus un genre de *Cossoni* strictement partagé avec Madagascar.

Sainte Hélène, 15: *Pentarthri* (8), *Cossoni* (5), *Rhyncoli* (2).

Pacifique, 18: *Trypetini* (1, Salomon), *Dryophthori* (2), *Pentarthri* (4), *Cossoni* (11).

Malaisie, 10: *Dryophthori* (1), *Pentarthri* (4), *Cossoni* (5).

Hawaï, 9: *Trypetini* (1), *Pentarthri* (2), *Cossini* (4), *Rhyncoli* (2).

Nouvelle Zélande, 40: *Trypetini* (3), *Pentarthri* (31), *Cossoni* (3), *Rhyncoli* (3).

Ainsi, dans tous ces territoires insulaires, même les plus perdus, tels que Ste Hélène et les Hawaï, l'assortiment les éléments endémiques reste varié, c'est-à-dire composé de plusieurs lignées primitives. Cette constatation emporte la conviction que ces îles se rattachaient autrefois, directement ou indirectement à des continents, et l'endémicité devait être alors tout au plus à son début.

Les rapports que les Hawaï ont pu avoir avec les grandes terres sont encore discutés et incertains. A l'égard des Coléoptères, PERKINS ne peut se résoudre à rattacher l'archipel à une région continentale quelle qu'elle soit, et HOLDHAUS (IV<sup>e</sup> *Mémoire de la Société de Biogéographie*, 1934, du reste, n'apportent aucune clarté sur le problème. Les plantes, en revanche (A. GUILLAUMIN, *loc. cit.*, p. 266), révéleraient des affinités sûres avec l'Amérique. — Pour Sainte Hélène, ces insectes, dont l'endémicité est totale, sont également muets. Mais il y a le grand Carabique *Haplothorax Burchelli*, que JEANNEL (Les Calosomes, p. 9

<sup>4</sup> Remarquer encore la richesse de l'Amérique du Nord en lignées primitives (cf. supra § 11).

## VI — LES TRANSPORTS PAR LA NAVIGATION

Les espèces de *Cossoninae*, presque toutes lignivores ou radicivores, sont prédestinées à la diffusion par la voie maritime. Les exemples abondent.

*Transports dans l'intérieur d'un secteur ou d'un archipel rassemblé*

Secteur malgache: entre Madagascar, les Comores, les Mascareignes, *Dryophthorus atomus*, *Pentarthrum humile*, *Stenotrupis distinguenda*, *Proëces nigrifrons*, — entre Madagascar et Pacifique: entre Australie et Nlle Guinée, *Isotrogus bilineatus*, — entre Nlle Guinée et les Séchelles, *Orthotemnus filiformis*, — dans les Mascareignes, *Cossonus marginalis*. Moluques, *Aphyodes diura*, *Homalotrogus angustifrons*, *Steresborus affinis*, *Orthotemnus reflexus*.

Indomalaisie: entre Bornéo, Sumatra et les Célèbes, *Rhyrax obscurus*, — entre Ceylan, Penang et Malacca, *Psilosomus bebes*.

Indomalaisie et Pacifique: entre Nlle Guinée, Java et Sumatra, *Cossonus basalis*, *C. ephippiger*, *Oxydema elongatum*, — entre la Nlle Guinée, les Moluques et l'archipel malais, *Phloeophagosoma signaticolle*, *Cossonus Illigeri*, *Eutornus ferrugineus*, *Hyponotus subpubescens*.

Amérique centrale et Antilles: *Cossonus corticalis*, *C. foveatus*, *C. scrobiculostratus*, *C. spathula*, *C. thoracicus*, *Calcyforus excavatus*, *Stenancylus Colombi*.

Entre Chili et Juan Fernandez: *Pachytrogus crassirostris*.

*Transports entre régions éloignées*

*Dryotribus mimeticus*: Australie, Hawaï, Floride, Chine.

*Pentarthrum cylindricus*: Amér. centr. et du Sud, Ascension, îles melaises, Samoa.

*Torostoma apicale*: Nlle Zélande et Juan Fernandez.

*Amaurorrhinus Clermonti*: S. O. de la France et Madère.

*Pselactus spadix*: Euroméditerranée, Madère, Amér. du Nord, Australie, Nlle Zélande.

*Caulotrupis aeneopicea*: Europe moy. et mérid., Açores, Corse, Corfou.

*Phloeophagosoma subcaudatum*: Nlle Guinée, Tahiti, Madagascar.

*Rhyncolosoma dubium*: Christmas, Séchelles.

*Cossonus elongatulus*: Afrique du Sud, îles malgaches, Indes, — *C. incivilis*: Afr. du S., Séchelles. — *C. suturalis*: Afrique, Madagascar, Comores, Séchelles.

*Rhyncolus procer*: Java, Maurice.

*Dendroctonomorphus muriceus*: Java, Séchelles.

*Stenoscelis hylastoides*: Le Cap, Ste Hélène.

*Caulophilus latinasus*: Amér. du Nord, Madère, Inde.

Certains de ces partages, ceux surtout entre des îles voisines ou dans les limites d'un archipel concentré, peuvent tenir à la diffusion primitive de l'espèce, supposée peu variable et qui se serait maintenue telle sur les débris d'un territoire autrefois continu. Mais étant donné l'endémisme intense des *Cossoninae* insulaires, il est plus probable que la diffusion s'est faite par la navigation, d'abord celle des indigènes, certainement très ancienne, puis celle des bâtiments modernes, capables de longues traversées, et qui ont propagé tant d'animaux<sup>5</sup> et de plantes dans les contrées les plus éloignées de leur patrie d'origine.

Ce mécanisme, évident pour le partage excentrique d'une même espèce, ne vaut pas, ou ne vaut guère pour le partage entre espèces dépendant d'un même genre. S'il

<sup>5</sup> Les *Bostrychidae*, entre bien d'autres, en donnent des exemples remarquables par la précision et l'ampleur. Quatre espèces, *Apate terebrans*, *A. monachus*, *Xylopertha picea*, *Xylionulus transvean*, "indubitablement africaines", se retrouvent en Amérique centrale et en Amérique du Sud. P. LESNE a démontré (cf. Les Coléoptères Bostrychides de l'Afrique tropicale française, 1924, p. 36—37) que ces transgressions datent du transport des Noirs africains, réduits en esclavage, dans les Antilles et sur les côtes du Brésil. Les bâtiments négriers, chargés de bois, d'ustensiles, de racines et de tubercules desséchés, ont servi de véhicules. — Il a décrit une migration inverse, également suivie d'acclimation, celle du *Trogoxylon aegale*, "import selon toute apparence à travers l'Atlantique, de l'Amérique tropicale en Afrique occidentale."

existe, il doit être rare, et tel est peut-être les cas des deux *Macrancylus*, endémiques l'un aux Hawaï, l'autre aux Etats-Unis, celui-ci éventuellement importé de l'archipel où sa présence n'aurait pas encore été constatée.

On peut envisager enfin le transport, par les courants marins, de matériaux arrachés aux terres lors des cataclysmes, puis échoués sur d'autres rivages, apportant les êtres vivants qui ont pu s'abriter dans le bois ou dans les racines.

## VII — LA DIFFUSION HISTORIQUE DES *COSSONINAE* PEUT-ELLE SE DÉDUIRE DE LEUR RÉPARTITION ACTUELLE ET DE LEUR TAXONOMIE?

La sous-famille des *Cossoninae*, encore prospère, partagée en deux tribus et 9 sous-tribus, est mondiale. La masse des lignées secondaires est tropicale et australe (*supra* § II), mais certaines se sont anciennement installées dans l'hémisphère boréal et l'une d'elles, les *Hormopi*, n'existe que là. Il est donc possible que la diffusion de la super-lignée, déjà totale, ait été épuilibrée dans les deux hémisphères à une époque donnée, puis chassée au Sud par le froid.

Mais il faut bien avouer que les données dont on dispose, très insuffisantes, se prêtent mal à une synthèse historique :

1°) De toute évidence, les explorations sont incomplètes. Bon nombre de disjonctions se combleront ou s'expliqueront à la suite de recherches mieux poursuivies.

2°) La répartition de ces insectes lignicoles ou radicales est liée à celle des végétaux auxquels ils sont attachés. La géographie des plantes hôtes doit être précisée avant d'aborder la répartition de leur clientèle.

3°) La taxonomie arriérée des *Cossoninae* est peut-être artificielle. Elle distingue une dizaine de catégories supérieures au genre. Que valent-elles et quelle est leur hiérarchie ? Qu'il s'agisse de la structure générale du groupe ou de la composition des collections locales, rien ne sera certain si l'on ne dispose pas d'une classification naturelle. Il en est ainsi notamment pour l'ensemble même des *Curculionidae*.

4°) La paléogéographie du secteur pacifique est loin d'être fixée. Une région riche, à la fois très tendue et très morcelée échappe ainsi, pour une bonne part, aux essais d'interprétation. De là peut-être l'irrégularité apparente dans le peuplement des archipels et l'obscurité de leurs liaisons.

5°) Le rôle du grand continent antarctique, au Secondaire et au début du Tertiaire, c'est-à-dire avant sa glaciation actuelle qui date peut-être déjà du Miocène (voir les cartes de Köppen et Wegener. *Die Klimate der geologischen Vorzeit*, 1924, p. 116—117), — a dû être très important dans la diffusion de beaucoup de lignées primitives, telles que celle des *Cossoninae*. Les rapports évidents des faunes entre les terres australes et le reste du globe le prouvent. Mais la Vie a virtuellement disparu de l'Antarctide et, avec elle, toute possibilité d'interpréter ce rôle d'après les éléments de l'époque actuelle.

6°) Les quelques fossiles connus sont insignifiants. On a exhumé et décrit 5 "*Cossonus*" oligocènes et miocènes (Aix, Oeningen, Florissant). Sont-ce vraiment des *Cossonus* ? Rien dans le Bernstein, ni dans les dépôts quaternaires.

On ne peut faire fond sur des bases aussi fragiles. Les *Cossoninae* sont d'ailleurs au même degré de connaissance que la plupart des divisions dans l'Ordre des Coléoptères. A supposer qu'on ait réussi la reconstitution de leur histoire, cette synthèse n'aurait pas

une valeur d'extrapolation, étant donné l'indépendance de l'évolution maintes fois constatée chez les lignées primitives.

### VIII — AUTRES GROUPES DONT LA DIFFUSION PARAÎT LIÉE A L'INFLUENCE MARITIME

On a démontré, (§ II et III) que les *Cossoninae* des régions tropicales et australes ont six fois plus de genres et cinq fois plus d'espèces endémiques que la Holarctide, — et sont presque quatre fois plus nombreux dans les régions péninsulaires et insulaires que sur les continents. Au moins deux grandes lignées de Coléoptères ont même allure.

#### 1°) *Aglycyderidae* et *Proterhinidae*.

"The families *Proterhinidae* and *Aglycyderidae* are hard to separate" (Sharp a. Muir, Male genital tube in Coleoptera, 1912, p. 528—29). "The presence of wings in *Aglycyderes* but non in *Proterhinus* is the only distinct difference we can point to a present". Il n'y a donc pas lieu de maintenir deux familles distinctes, et cette opinion prévaut aujourd'hui (Perkins, 1932).

*Aglycyderes*, représenté par son unique espèce *setifer* Westw. est limité aux Atlantides : "*Habitat* Canarienses (ins. omnes), vel in caulibus *Euphorbiarum* putridis vel sub cortice *Ficorum*, arido laxo inde congregans" (Wollaston). En Nouvelle Calédonie et en Nouvelle Zélande, le genre est remplacé (Paulian, *Rev. franç. d'Entom.* X, 1944, p. 113—119) par les *Platycephala* (3 espèces).

Quant aux *Proterhinus*, leur réunion massive est aux Hawaï, où leur polymorphisme est extravagant : 122 "espèces" décrites. Ils existent aussi aux Marquises (2 espèces), aux îles Phoenix (1 espèce), cf. Mumford a. Adamson, IV<sup>e</sup> *Mémoire de la Sté de Biogéographie*, 1934, p. 225, peut-être encore aux Samoa. Presque tous vivent dans le bois mort et altéré, ou sous les écorces, quelques-uns dans le pétiole des feuilles, et les larves de deux espèces sont mineuses dans les feuilles de *Broussaitia arguta* (Swezey cité par Holdhaus in *Handbuch Schröder*, II, p. 710).

Sharp et Muir (l.c. p. 621—22) placent les *Aglycyderidae* \* *Proterhinidae* dans le complexe des *Phytophagoidea* auprès des *Anthribidae*, tout en remarquant que "they might be placed equally as well with the Cucujoidea". C'est, de toute évidence, une très ancienne lignée, actuellement déchue et préservée dans la faune insulaire. Peut-être la retrouvera-t-on ailleurs. Sa répartition antipodique est strictement "maritime" et sa présence aux Canaries est pleine d'intérêt.

#### 2°) *Anthribidae* *Anocerinae*

(cf. *Coleopt. Catal.* pars 102, anc. P. Wolfrum, 1929, p. 101—120).

Cette sous-famille ou tribu réunit 40 genres et 266 espèces. Il s'agit d'insectes vivant, comme les *Cossoninae*, dans le bois mort, mais, à en juger par la collection européenne, plus ou moins liés au mycélium des Champignons qui se développent dans les tissus ligneux altérés.

##### a) Prédominance tropicale et australe:

La Holarctide a un genre nord-américain, *Euxenus* (3 espèces), un genre partagé entre l'Amérique du Nord et Madère, *Xenorchestes* (2), un genre européen, *Pseudorchestes* (1), un genre *Holosilpna* partagé entre Amérique du Nord (1) et Amérique centrale (2), 3 *Choragus* en Amérique du N, 8 en Euroméditerranée, 6 au Japon, enfin au Japon 4 genres partagés, représentés par 6 espèces endémiques.

Au total, 3 genres endémiques ou épidémiques (*Choragus* et *Holosilpna* ont des représentants au Sud), et 30 espèces endémiques, — contre 35 genres et 236 espèces appartenant aux régions tropicales ou australes.



## b) Prédominance de la faune insulaire ou péninsulaire:

<i>Continents</i>		<i>Iles ou presqu'îles</i>	
Australie:	3 g. (6 g. part.) avec 11 esp.	Atlantides:	0 g. (1 g. part.) avec 1 esp.
Asie:	0 » (4) » 12 »	Japon:	0 » (5) » 12 »
Afrique:	3 » (2) » 24 »	Formose:	0 » (1) » 1 »
Amér. du: 1 » (3) » 6 »		Ceylan:	0 » (3) » 6 »
Nord		Indomal. et	
Amér. du: 0 » (1) » 1 »		Pacif.:	3 » (8) » 108 »
Sud		Amér. (isthmes	
Euroméd.: 1 » (1) » 9 »		centr.): 2 » (4) » 11 »	
		Sect. malg.: 9 » (6) » 34 »	
		Ste Hélène: 1 » (2) » 26 »	
		Nlle	
		Zélande: 1 » (1) » 3 »	
		16	202
	8		
	63		

Il y a, dans les *Anocerinae*, 16 genres partagés entre territoires insulaires ou péninsulaires, et aussi quelques partages d'espèces. L'une de celles-ci, *Araecerus fasciculatus*, est cosmopolite, elle vit actuellement au voisinage de l'homme, dans les danrées coloniales ou les fruits secs.

On voit que la disproportion, soit entre hémisphère N. et hémisphère S., soit entre continents et territoires soumis à l'influence maritime, est très analogue à celle qui a été décrite (§ II et III) chez les *Cossoninae*.

Deux détails offrent un certain intérêt:

1°) On a déjà remarqué (§ V) que les *Cossoninae*, si nombreux et variés (15 genres et 55 espèces endémiques), à Ste Hélène, sont pourtant incapables d'éclairer l'origine de la faune dans cette île perdue, mais que le Calosome *Haplothorax Burchelli* se rattache aux *Ctenosta* africains. Or, Ste Hélène possède 3 genres d'*Araecocerinae*: *Acarodes*, unispécifique et endémique, *Homaeodera* avec 13 espèces, plus une 14ème à Rodrigues des Mascareignes, et *Notioxenus* avec 12 espèces, plus 2 au Japon et 3 en Amérique centrale et aux Antilles. Ce dernier partage esquisse les relations probables que l'île a pu avoir avec le continent américain et qui, combinées aux relations avec l'Afrique démontrées par le Calosome, permettent d'interpréter biogéographiquement la situation insolite de ce minuscule territoire.

2°) La très petite île de Rodrigues, excentrique à l'Est dans l'Archipel des Mascareignes, n'a, en fait de *Cossoninae* qu'un seul *Pentarthrum* (endémique). Mais elle n'a pas moins de 6 genres d'*Anthribidae*, dont un, *Hormiscops*, partagé avec les Séchelles (4 esp. aux S., 1 à R.) appartient à la sous-famille des *Pleurocerinae*, les 5 autres à celle des *Araecocerinae*: 3 endémiques, *Dinephrus* (2), *Balanodes* (1), *Talpella* (1), un *Achoragus* (3) partagé avec les Séchelles, et un, *Homaeodera*, cité plus haut et partagé avec Ste Hélène. — Au total, 3 genres endémiques, 3 genres partagés et 8 espèces endémiques. C'est une concentration bien remarquable pour territoire insulaire de 42 milles carrés.

D'ailleurs, le secteur malgache est particulièrement riche en *Anthribidae*: Aux 9 genres et aux 34 espèces d'*Anocerinae* figurant au tableau ci-dessus s'ajoutent respectivement 20 et 63 unités dans les *Pleurocerinae*, ce qui fait un total de 29 genres et 97 espèces endémiques, en majeure partie déçits de Madagascar même.

## IX — L'INFLUENCE MARITIME

I — Les îles, quand la collection de leurs êtres vivants est riche et choisie, sont présumées être les fragments de continents, dont elles ont reçu autrefois et conservé une partie des animaux et des plantes qui s'y trouvaient avant la dislocation. Quand

leur collection est pauvre et banale, on conclut qu'elles ont surgi de l'Océan en tant que pitons volcaniques ou constructions de madrépores et que le peu de vie qui s'y trouve provient d'introductions accidentelles. — C'est la distinction classique entre îles dites continentales et îles océaniques.

Même quand elle est riche, une faune insulaire a toujours des lacunes, d'autant plus fortes que l'isolement géographique est plus marqué. En revanche, l'amixie dans l'état insulaire favorise l'endémisme, qui peut prendre un développement extraordinaire (les 122 *Proterhinus* des Hawaï). De plus, les îles recèlent souvent des reliques disparues sur les grandes terres voisines, par l'effet des vicissitudes climatiques auxquelles les fragments ont échappé. — En somme, les îles ont des collections appauvries, mais aussi partiellement préservées.

L'appauvrissement, l'amixie, la préservation résultent de l'isolement, qui est une condition mécanique. La mer a joué le rôle d'une barrière, et toute autre barrière peut se former ailleurs, avec les mêmes effets. Rigoureusement, on ne peut pas invoquer ici une "influence maritime".

2 — La même restriction s'impose lorsqu'il s'agit d'être qui, comme les *Cossoninae*, se développent dans des plantes (ligneuses) souvent localisées au voisinage immédiat de la mer. Ces plantes sont aussi, soit celles qui préexistaient sur les grandes terres avant le morcellement, soit des reliques conservées dans les îles, soit des endémiques favorisées. Dans tous ces cas, leur présence est due à l'isolement du territoire insulaire et cette condition mécanique est applicable à l'animal qui vit à leurs dépens. La conclusion demeure : il ne s'agit pas d'influence maritime.

Un exemple de l'illusion où peut mener l'insuffisance des recherches combinée au prestige d'une apparence forte et prolongée, est donné par les *Aphanarthrum*, Scolytides strictement attachés au bois mort des Euphorbes ligneuses ou cactiformes. Ce petit genre, découvert par WOLLASTON au cours des années 1850, est resté longtemps l'apanage des archipels atlantiques. Puis, vers 1922, il a été retrouvé en face, dans l'"enclave macaronésienne" du Maroc austro-occidental, et ensuite (1940) plus au Sud, à Dakar sur le littoral sénégalais. Tel quel, il restait encore "atlantique" ou "océanique". Mais on vient de le rencontrer (A. VILLIERS, *Bull. Soc. ent. Fr.*, 1946, p. 140) à Bamako, en plein continent africain. De ce fait, il perd son privilège biogéographique : ce n'est plus un élément insulaire ou maritime, ni même, en tant que genre, un composant de la série atlantique, c'est simplement un satellite des grandes Euphorbes d'origine africaine, abondantes, à la vérité, et richement différenciées dans toutes les îles de l'Ouest, sans toutefois avoir disparu du continent d'où elles provenaient.

3 — Mais quand, dans les îles ou sur tout autre rivage, on voit des séries d'Arthropodes, non seulement localisées au voisinage immédiat de la mer, mais dépendant rigoureusement de conditions engendrées par la mer elle-même, cette influence directe n'est plus contestable.

La collection des Coléoptères euroméditerranéens, par exemple, ne renferme pas moins d'une cinquantaine de genres qu'on peut qualifier de "maritimes", dont près de la moitié entièrement composés d'espèces obéissant à cette écologie. Ce sont des submarins (du type *Aëpini*, *Diglossa*, *Micralymma*), des carnassiers (type *Eurynebria*, *Schrites*), des algophages (type *Bledius*, *Actinoptery*, *Ochthebius*, *Cercyon*) et leurs prédateurs spécialisés (type *Cillemus*, *Dyschirius*, *Cafius*, *Halacritus*), des parasites de plantes marines (type *Macroplea*) ou de végétaux halophiles exclusifs au rivage (type *Polydrosus*); des saprophages (type *Saprinus*, *Phaleria*) des lignivores (type *Icidus*, *Pachypus*, *Styphloderes*), des détriticoles (type *Brachemys*, *Holoparamesus*, *Anthicus*), des sabulicoles (type *Psammobius*, *Aegialia*).

On a relevé plus haut (§ III), parmi les seuls *Cossoninae* français, 4 espèces sur 30, soit 13 % qui sont des lignicoles strictement maritimes. Etant donné l'uniformité de la vie larvaire chez tous ces Charançons, le chiffre peut être extrapolé sans grand excès et il est permis de conclure que les *Cossoninae*, dont l'immense majorité est localisée dans

les régions littorales, le sont pour bonne part grâce à une influence maritime, directe ou indirecte, à laquelle ils répondent.

Il en est probablement de même pour ces nombreuses espèces, ou séries d'espèces, qu'on voit alignées, non seulement sur les côtes océaniques de l'Europe et du Maroc, mais sur celles de la Méditerranée, sous la forme d'"aires en L" familières aux biogéographes. Il n'est guère possible d'expliquer cette disposition sans tenir compte de l'influence de la mer.

4 — De quelle nature est cette influence ? On la saisit aisément chez les organismes très étroitement adaptés dont on a parlé à l'instant (§ 3) : influence directe pour les Arthropodes submarins, légèrement détournée chez les algophages et leurs satellites, moins distincte et sans doute plus relâchée chez les parasites des végétaux halophiles (qui peuvent se rencontrer dans les zones salées de l'intérieur), comme aussi chez les animaux vivant dans les bois morts roulés sur le rivage.

On la distingue moins bien chez les êtres qui "suivent" le littoral maritime ou s'en écartent peu. Il est probable qu'il s'agit d'une action climatique. La mer est à la fois un régulateur de la température et un élément du degré hygrométrique de l'air. Il serait invraisemblable que les êtres vivants ne réagissent pas à ces deux facteurs toujours prépondérants dans leur milieu écologique.

Quelle qu'elle soit, et si imprécise qu'elle apparaisse encore dans son mécanisme intime, l'influence de la mer n'est pas douteuse. La statistique brute (§ III), à cet égard, donnait des chiffres dépassant la réalité. Combinée avec l'écologie<sup>6</sup> et corrigée par elle, elle peut et doit aboutir à une représentation correcte.

## X — CONCLUSIONS

L'analyse statistique des *Curculionidae Cossoninae* a montré que dans l'état des connaissances, il n'était guère possible (§ VIII) d'élaborer une restitution taxonomique et biogéographique satisfaisante de ce groupe. L'histoire de sa diffusion est pour le moment indéchiffrable. Une grande irrégularité déconcerte la répartition actuelle du peuplement dans la région pacifique, même dans le secteur malgache, les Mascareignes, par exemple (Rodriguez) vis-à-vis des Séchelles. On notera encore la relative pauvreté, peu explicable du vaste secteur australien (13 genres et 163 espèces endémiques) par contraste avec la Nlle Zélande, (39 genres et 164 esp. endémiques) bien plus petite. — Ces difficultés ne sont nullement particulières aux *Cossoninae*, on les rencontre à tout instant dans bien des familles ou sous-familles de l'Ordre.

Mais elle a révélé aussi, ou confirmé, plusieurs données dès maintenant valables :

L'endémicité si remarquable des régions insulaires et péninsulaires n'est pas limitée ici à des espèces ou à des genres affines. L'assortiment de la collection endémique sur ces petits territoires comprend toujours (§ V) au moins 3, quelquefois 4 sous-tribus de *Cossoninae*, preuve que les lignées étaient déjà variées dès avant leur différenciation.

Ceci n'est vrai que pour les îles éloignées dans l'Océan. Dans celles qui sont proches de la masse continentale et s'en sont détachées à une date plus ou moins récente, l'endémicité est purement spécifique : les Antilles (§ V) ont 45 espèces de *Cossoninae*, mais pas une n'appartient à un genre endémique dans ces îles.

Quand sur une même région, des familles ou sous-familles se prêtent à la différenciation endémique, l'incidence de l'endémicité n'a rien de régulier, et sur un même point peut-être très disproportionnée selon le groupe d'Insectes : le secteur malgache est

<sup>6</sup> Voir "Ecologie et Statistique en Biogéographie (M. Prenant, Géographie des Animaux, Coll. Arm. Colin, 1933, p. 186—188).

riche à la fois en *Cossoninae* et en *Anthribidae* endémiques (§ VIII), mais Madagascar, bien plus riche en *Anthribidae* que les archipels satellites, est bien plus pauvre en *Cossoninae* (§ V) que les Séchelles. En revanche (§ VIII), Rodriguez des Mascareignes, encore plus petite que Ste Hélène, et qui en fait de *Cossoninae* n'a qu'un seul *Pentarthrum*, ne possède pas moins de 6 genres, dont 3 endémiques, et 8 espèces endémiques d'*Anthribidae*.

Le genre *Pentatemnus* (§ IV), qui partage ses deux espèces entre les Canaries et les îles du Cap Vert, est l'un des rares témoins, mais un témoin parfaitement authentique, de la communauté des faunes entre les Atlantides, du Nord et celles du Sud, autrefois marquée, presque effacée aujourd'hui.

Quant à l'influence maritime, dont cette étude était le premier prétexte, elle n'intervient pas, comme la statistique brute (§ III) semblait le montrer, dans la masse entière des éléments aujourd'hui rassemblés sur les rivages. Mais elle existe cependant pour un bon nombre, lorsqu'on tient compte de l'écologie (§ IX). Les *Cossoninae* y sont sensibles et certains sont réellement attirés ou favorisés par le voisinage de l'eau marine. Pour eux, comme pour beaucoup d'Arthropodes appartenant à des groupes variés, l'influence maritime est certaine.

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ZUR AUTKOLOGIE EINIGER STENUS-ARTEN IM LICHTE  
SYNÖKOLOGISCHER BEOBACHTUNGENVon *Olavi Renkonen*

Die Gattung *Stenus* scheint eine ökologisch ziemlich einheitliche Gruppe zu bilden. Mit einigen wenigen Ausnahmen sind die ihr zufallenden Arten recht polyphage Raubtiere, die sich an mancherlei weichhäutigen Arthropoden (und insbesondere deren Larven), Kleinwürmern u. dgl. m. ernähren. Der überwiegende Teil der Arten ist deutlich hygrophil, an Ufern, in Sümpfen usw. lebend. Als ein besonders beachtenswerter Umstand ist zu erwähnen, dass die Arten der Gattung *Stenus* zumal an feuchten oder nassen Stellen oft sogar massenhaft angetroffen werden, so dass z. B. der ganze übrige Käferbestand neben ihnen nur eine untergeordnete Bedeutung erhält. Es scheint somit, wie wenn sich der Wettbewerb der *Stenus*-Arten um die Nahrung meistens in der Tat lediglich zur Hauptsache innerhalb der eigenen Gattung abspielte. Die *Stenus*-Arten scheinen somit oft den wesentlichen Hauptbestandteil gewisser Synusien (sensu Gams<sup>1</sup>), der kleinsten topographisch-synökologischen Bauteile der Biozöosen, zu repräsentieren.

Wenn man als Feldökologe danach strebt, die Lebensansprüche bestimmter *Stenus*-Arten zu klären, so stösst man oft auf grosse Schwierigkeiten, denn manchmal kann man einer gewissen Art an scheinbar recht verschiedenartigen Standorten begegnen und andererseits ist eine gewisse Art keineswegs immer dort zu finden, wo ihr, menschlich gesehen, ganz vortreffliche Lebensbedingungen zu Gebote stehen müssten. Sich aber in solchen Fällen auf Zufälligkeiten verlassen, muss Selbsttäuschung, ein Aufgebot der menschlichen Schwäche und Bequemlichkeitslust bedeuten. Ich habe in einigen Arbeiten<sup>2</sup> zielbewusst für die Anschauung gekämpft, dass nur die Arten selbst als Indikatoren für die Tauglichkeit ihrer Wohnstellen zu gelten hätten. Je zahlreicher eine bestimmte Art an einer bestimmten Stelle vorkommt, desto besser muss diese Stelle den ökologischen Ansprüchen der betreffenden Art entsprochen haben.

Meiner Auffassung nach könnten die Untersuchungen über den Aufbau der *Stenus*-Synusien mancher Standorte geeignet sein, auch solche Fragen zu beleuchten, deren Klärung nicht einzig durch autökologische Feldbeobachtungen möglich ist. In diesem Sinne habe ich nun etwa während der letzten zwanzig Jahre quantitative *Stenus*-Proben aus verschiedenen Teilen Finnlands und teilweise auch aus dem übrigen Fennoskandien gesammelt. Dabei habe ich im allgemeinen danach gestrebt, die Proben der grösseren Vergleichbarkeit halber von möglichst gleichgrossen Probeflächen zu nehmen, die trotz ihrer möglichst engen Begrenzung und der dadurch erzielten Einheitlichkeit dennoch hinreichend gross sind, um die wahren Dominanzverhältnisse der Arten schon deutlich genug an den Tag zu bringen. Nachstehend mögen einige Beispiele vorgeführt werden, in welcher Weise dieses Material imstande ist, einige Fragen bezüglich der Autökologie gewisser *Stenus*-Arten zu klären.

<sup>1</sup> Gams, H.: Prinzipienfragen der Vegetationsforschung. Vierteljahrsschr. d. Naturforsch. Ges. in Zürich. 63. 1918.

<sup>2</sup> Renkonen, Olavi: Statistisch-ökologische Untersuchungen über die terrestrische Käferwelt der finnischen Bruchmoore. Ann. Zool. Soc. Zool.-Bot. Fenn. Vanamo. 6,1. Helsinki 1938. — Ders.: Die Carabiden- und Staphylinidenbestände eines Seeufers in SW-Finnland. Ann. Ent. Fenn. 10, 1—2. Helsinki 1944.

I. *Die Konstanz der Begleitarten.* — Bei der Klärung der ökologischen Ansprüche einer bestimmten Art hat man sich im allgemeinen damit begnügt, die Milieuverhältnisse an den Fundstellen zu analysieren. Auf diese Weise kann man oft in der Tat recht weit kommen. Handelt es sich aber namentlich um eine verhältnismässig seltene Art, so ist das Material von nur wenigen Fundstellen nicht hinreichend genug, um etwaige sichere Schlüsse zu erlauben. In solchen Fällen kommt uns nun das synökologische Material zur Hilfe. Ich nehme ein Beispiel. Es gibt in Fennoskandien zwei recht nahe verwandte *Stenus*-Arten, *St. confusus* und *St. confusoides*, beide ziemlich selten, so dass über ihre Fundstellen im ganzen nur verhältnismässig wenige Aufzeichnungen vorliegen. In Tabelle 1 habe ich nun alle diejenigen *St. confusus*-Bestände zusammengestellt, in denen die Art durch mindestens zwei Individuen repräsentiert ist und die somit als mehr oder minder normale Fälle zu betrachten sind. In den Beständen findet man dazu eine Anzahl andere *Stenus*-Arten, deren Vorkommen in der Tabelle durch Kreuze angezeigt ist. Man ersieht, dass eine Art, nämlich *St. boops*, in fast jeder Probe vorhanden ist und somit als fast hundertprozentig konstante Begleit-Art des *St. confusus* gelten darf. Entsprechend habe ich die Konstanz von *St. confusus* in den *St. boops*-Beständen berechnet und den Wert 41 % gefunden. Dies muss natürlich bedeuten, dass die abstrakte Summe der Fundstellen von *St. confusus*, also der Standort der

Tabelle 1.

Stenus confusus J. Sahlb.- Bestände	Nord- Finnland	Seen- Finnland	Süd- Finnland	Konstanz %
<i>S. biguttatus</i> L.		+		8
<i>S. bipunctatus</i> Er.		+		8
<i>S. junco</i> F.		++++	+	31
<i>S. fasciculatus</i> J. Sb.	+++++	++		46
<i>S. strandi</i> Bck	+			8
<i>S. boops</i> Ljungh	+++++	+++++		92
<i>S. melanarius</i> Steph.	+ ++	+		31
<i>S. canaliculatus</i> Gyll.		+		8
<i>S. nitens</i> Steph.	+	+	+	23
<i>S. labilis</i> Er.	++	+		23
<i>S. fuscipes</i> Grav.		++		15
<i>S. argus</i> Grav.			++	15
<i>S. cautus</i> Er.		+	+++++	38
<i>S. nanus</i> Steph.		++	+	23
<i>S. carbonarius</i> Gyll.		+++	++	38
<i>S. scabriculus</i> J. Sb.		+	+	15
<i>S. opticus</i> Grav.		+	+	23
<i>S. nigrifrons</i> Gyll.		+		8
<i>S. cicindeloides</i> Sch.		+	+	23
<i>S. niveus</i> Fauv.	+			8
<i>S. binotatus</i> Ljungh		+	++	23
<i>S. pseudopubesc.</i> Str.	+	+		15
<i>S. palustris</i> Er.			+	8

Art, ansehnlich enger ist als derjenige von *St. boops*, sowie dass sich der Standort von *St. confusus* zum wesentlichsten Teil innerhalb desjenigen von *St. boops* befindet. Eine genauere Charakterisierung des Standorts von *St. confusus* ermöglicht sich ferner durch die Heranziehung einiger anderen wichtigeren Begleitarten, wie *St. fasciculatus*, *St. cautus* und *St. carbonarius*, deren Standorte wegen der Häufigkeit der betreffenden Arten schon relativ gut bekannt sind. — Die Tabelle 2 gibt einen entsprechenden Überblick über die *St. confusoides*-Bestände. In diesen wiederum erreicht *St. boops* einen sehr niedrigen Konstanzwert, dagegen finden wir für *St. melanarius* ein Konstanzprozent von nicht weniger als 94 %. Der eigene Konstanzwert von *St. confusoides* in den *St. melanarius*-Beständen beläuft sich auf 45 %, und demnach dürfte das ökologische Verhältnis dieser beiden Arten demjenigen von *St. confusus* und *St. boops* ziemlich ähnlich sein. Eine eingehende Charakterisierung des Standorts von *St. confusoides* lässt sich verhältnismässig genau mit Hilfe der recht treuen Begleitarten *St. nivens*, *St. cicindeloides* und *St. fornicatus* durchführen.

Tabelle 2.

Stenus confusoides Renk.- Bestände	Nord- Finnland	Seen- Finnland	Konstanz %	
S. junco F.		+ + + +	24	
S. fasciculatus J. Sahlb.		+ + + +	24	
S. lustrator Er.		+	6	
S. proditor Er.	+	++ ++	29	
S. scrutator Er.	+		6	
S. boops Ljungh	+		6	
S. melanarius Steph.	+ + + + + + + + + + + + + + + +		94	
S. ampliventris J. Sahlb.		+	6	
S. nitens Steph.	+		6	
S. fuscipes Grav.			+	6
S. argus Grav.		+ +	+ +	24
S. circularis Grav.		+	+	12
S. pumilio Er.		+	+ +	18
S. carbonarius Gyll.	+		+ +	18
S. hyperboreus J. Sahlb.	+			6
S. opticus Grav.	+	+++		24
S. formicetorum Mnn.		+		6
S. tarsalis Ljungh		+		6
S. cicindeloides Schall.		+	+ + + + + + + +	47
S. fornicatus Steph.		+	+ + + + + + + +	47
S. pallitarsis Steph.		+		6
S. niveus Fauv.	+ + + +	+ + + + + + + +		71
S. binotatus Ljungh		+	+ + + + + +	41
S. pseudopubesc. Str.		+	++	18
S. bifoveolatus Gyll.	+ +			12
S. palustris Er.		+		6

II. *Die allgemeine Vitalität.* — Die obigen Tabellen zeigen, dass in den Beständen eine Menge von verschiedenen *Stenus*-Arten vertreten sind. Dies bedeutet, dass es sich um einen ständigen Wettbewerb um die Nahrung zwischen den Arten handeln muss. Dabei wird diejenige Art am besten gedeihen, die unter den gegebenen Umständen die kräftigste ist, d. h. am besten fähig ist, sich zu vermehren, Beute zu fangen usw. Ich gebrauche an dieser Stelle den Ausdruck *Vitalität*. Die Vitalität einer Art, die sich naturgemäss nur innerhalb des Standorts der Art offenbaren kann, spiegelt sich infolge des Wettbewerbs deutlich in der Individuendominanz wider. Berechnet man für jene Art den mittleren Dominanzwert in sämtlichen Beständen, in denen die Art vorkommt, so erhält man eine Zahl, die den relativen Vitalitätswert der betreffenden Art darstellt. Dieser Wert ist bei verschiedenen *Stenus*-Arten recht verschieden, wie es die Tabelle 3 zeigt. So zeigt z. B. *St. palposus*, eine typische Art der Sandufer, den Vitalitätswert von 83 %. Die Art tritt also an ihren Wohnort durchschnittlich 83 %ig dominierend auf. Dagegen beträgt der Vitalitätswert für *St. ciccindeloïdes* nur 9 %, denn diese Art ist als ein recht einseitiger Kletterer nicht imstande, sich die Kleintierwelt an den Gewürzeln der Seggenvegetation zunutze zu ziehen.

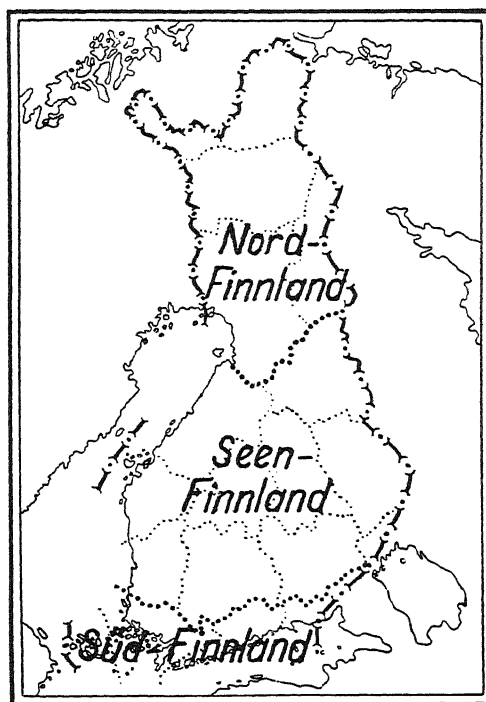
Tabelle 3.

Die allgemeine Vitalität einiger  
*Stenus*-Arten.

<i>S. palposus</i> Zett.	83 %
<i>S. labilis</i> Er.	44 %
<i>S. boops</i> Ljungh	30 %
<i>S. proditor</i> Er.	23 %
<i>S. gerhardti</i> Bck	22 %
<i>S. confusoides</i> Renk.	18 %
<i>S. fasciculatus</i> J. Sahlb.	17 %
<i>S. confusus</i> J. Sahlb.	16 %
<i>S. niveus</i> Fauv.	12 %
<i>S. ciccindeloïdes</i> Schall.	9 %

III. *Die regionale Vitalität.* — Es ist zu vermuten, dass die Vitalität einer bestimmten Art in den verschiedenen Teilen ihres Verbreitungsgebietes nicht die gleiche ist. Um hierüber näheren Aufschluss zu erhalten, habe ich mein Material in drei regionale Gruppen eingeteilt, und zwar in diejenigen von Nordfinnland, Seenfinnland und Südfinnland (Karte 1). Tabelle 4 zeigt die auf dieser Grundlage berechneten mittleren Dominanzwerte, die also für die in der Tabelle angeführten Arten die sog. regionale Vitalität widerspiegeln. Es erweist sich nun wirklich, dass die Vitalität regional variiert. Auch in solchen Fällen, wo eine Art, wir nehmen z. B. *St. proditor* und *St. confusus*, über das ganze Land verbreitet ist, kann man in ihrer Vitalität leicht eine südliche oder eine nördliche Tendenz gewahren. Leider reicht das mir jetzt vorliegende Material weder zu einer weitläufigeren noch zu einer detaillierten Auseinandersetzung der Frage aus. Ich möchte aber behaupten, dass eine die regionalen Vitalitätsabweichungen einer gewissen Art darstellende Karte über die Existenz- und Verbreitungsökologie dieser Art weit wertvollere Aufschlüsse liefert, als auch die vollkommenste gewöhnliche „Punktkarte“. Auf diesem Wege wird es endlich möglich, das *geographische Optimum* der einzelnen Arten, lokalisiert durch den höchsten Vitalitätswert, zu finden.





Karte 1. — Die regionale Einteilung des Materials.

Tabelle 4.

Die regionale Vitalität einiger Stenus-Arten.

	Nord-Finnland	Seen-Finnland	Süd-Finnland
<i>S. gerhardti</i> Bck	22	—	—
<i>S. labilis</i> Er.	47	2	—
<i>S. confusoides</i> Renk.	29	14	—
<i>S. niveus</i> Fauv.	18	10	—
<i>S. confusus</i> J. Sahlb.	18	16	13
<i>S. fascicularis</i> J. Sahlb.	16	18	—
<i>S. boops</i> Ljungh	27	30	31
<i>S. proditor</i> Er.	18	24	29
<i>S. palposus</i> Zett.	79	87	?
<i>S. cindeloides</i> Schall.	—	10	7

IV. *Über die Bedeutung der Begriffe „regionale Vitalität“ und „geographisches Optimum“.* — Die Auffindung der verschiedenen regionalen Vitalitätswerte und des geographischen Optimums für eine gewisse Art kann an sich kein Endziel für die ökologische Untersuchung bedeuten, sind doch diese Begriffe ihrem Charakter nach zunächst nur deskriptiv. Die erhaltenen Zahlenwerte bekunden gewisse synthetische Ergebnisse, erzielt mittels zahlreicher Einzelbeobachtungen. Vergleicht man diese Ergebnisse mit entsprechenden Aussenbedingungen, so ermöglichen sich wohl so manche Schlüsse bezüglich derjenigen Faktoren, die auf die Entstehung eben dieses Results eingespült haben. Wegen der synthetischen Natur der Ergebnisse kann den Schlüssen aber nur ein Wahrscheinlichkeitswert zukommen. Nur auf dem analytisch-experimentellen Wege, also durch künstliche Trennung der Einzelfaktoren, lässt sich der Einfluss der verschiedenen Faktorenkomponenten ermitteln. Die oben vorgelegten, ihrer Natur nach synthetischen Begriffe sind aber für die experimentelle Weiterforschung von zweierlei Bedeutung. Erstens führen sie der experimentellen Untersuchung gewisse Aufgaben zur Erforschung zu und zweitens liefern sie das endgültige Kriterium bei der Rückkehr zu den unter künstlichen Bedingungen durchgeführten experimentellen Analysen bei der gegenseitigen Wertung der Bedeutung der verschiedenen Faktorenkomponenten.

Die Anwendung der von mir vorgelegten Begriffe hat aber ihre bestimmten Grenzen. Ich habe hier nur mit der ökologisch einheitlichen Gattung *Stenus* operiert. Und es muss denn auch bemerkt werden, dass hierbei überhaupt nur eine Lebewesengruppe mit Synusien-Charakter in Betracht kommen kann. Als solche Objekte könnten m. E. z. B. die erdbewohnende Collembolenfauna, die Homopteren, die Dytisciden u. dgl. m. geeignet sein.

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## DIE THERMOPHILE FAUNA SÜDKÄRNTENS

Von *Harald Schweiger*

Während die thermophile Fauna von Podolien, Brandenburg, Niederösterreich, Ungarn und zum Teil auch der Schweiz von den verschiedensten Forschern untersucht wurde, liegen bis jetzt über die diesbezüglichen Gebiete in Nordjugoslawien, dem östlichen Oberitalien und Südkärnten keinerlei Angaben vor. Selbst Franz brachte, wie vorher schon Kunze, in seiner in den Zoogeographica III. p. 159 pp. erschienenen Abhandlung über „Die thermophilen Elemente der mitteleuropäischen Fauna u. s. w.“, mangels vorliegender Beobachtungen, keinerlei Angaben über die obenerwähnten Gebiete.

Ich selbst war nun im Laufe von verschiedenen Sammelfahrten zur Ueberzeugung gelangt, dass die thermophilen Lokalitäten vom östlichen Oberitalien, von Slovenien und Südkärnten, infolge der fast gleichartigen klimatischen Bedingungen denen sie in allen diesen Gebieten unterworfen sind, eine in ihrem Wesen ziemlich gleichartige, charakteristische Fauna besitzen müssen. Da mir das Gebiet von Südkärnten, durch seine in jeder Hinsicht günstige Lage, für meine Untersuchungen am geeignetsten erschien, begann ich im Frühjahr 1945 mit der planmässigen Erforschung seiner thermophilen Fauna.

Vorliegende Arbeit fusst auf Untersuchungen, die ich einerseits im Frühjahr 45 sowie im Juli und Oktober 47 im Gebiete des Jauntales und der Umgebung von Eisenkappel im südlichen Vellachtal durchführte, anderseits auf die Resultate einer in den Jahren 46 (13. 6.—1. 10) und 48 (15. 6.—1. 7.) erfolgten planmässigen Erforschung des Gailtales. Hierbei wandte ich mein Hauptinteresse bereits vom Anfang an der Ordnung der Coleoptera zu, versäumte es aber nicht, besonders bei den terricolen und subterranean Formen, auch von anderen Gruppen Material einzusammeln. Obgleich meine Aufsammlungen somit eine Reihe verschiedener Evertebratengruppen umfassten, werde ich in der vorliegenden Arbeit hauptsächlich die thermophile Coleopterenfauna des Gebietes behandeln und erst in zweiter Linie Beispiele aus den übrigen Gruppen, soweit diese bereits bearbeitet sind, anführen.

Das hier behandelte Gebiet, praktisch das südliche Drautal, das im Folgenden als Südkärnten bezeichnet wird, umfasst das gesamte Gailtal zwischen Mauthen und Villach, das Rosental südlich der Drau, sowie das Jaun- und Vellachtal. Die Südgrenze bilden die Karnischen Alpen und Karawanken, während das Gebiet im Norden bis zur Gailmündung durch die Drau, von da aber durch die Gailtaler Alpen begrenzt wird.

Das Gebiet von Südkärnten besteht im Ganzen genommen aus einer mehr oder weniger breiten Talschlucht, welche von Westen nach Osten verläuft und die an ihrer nördlichen und südlichen Seite von weiten Gebirgszügen, mit einer durchschnittlichen Höhe von 2000 m, begleitet wird.

Durch seine Breite und seine geringe Erhebung weicht das grosse Haupttal von den übrigen Kärntner Tälern sehr wesentlich ab. Die am tiefsten liegenden Teile, welche sich im Osten befinden, nimmt die verhältnismässig leicht kupierte Ebene des Jauntales ein, die eine Menge kleiner Seen in sich fasst. Die grössten unter diesen sind der Klopeiner-, Gösselsdorfer- und Zablatnig See. Im Osten wird das Jauntal, bis auf den schluchtartigen ca. 4 km breiten Draudurchgang, dessen tiefster Punkt sich bei Unter-

drauburg in einer Höhe von 364 m befindet, von den Ausläufern der Karawanken im Süden und dem südöstlichen Teil der Koralpe im Norden abgeriegelt.

Der zentrale Teil von Südkärnten wird zu seinem grössten Teil vom Gebiete des Faaker Sees ausgefüllt, das in seinem landschaftlichen Wesen vollkommen dem Jauntale gleicht. Die Verbindung zum Jauntal stellt das Rosental her, dessen Breite zwischen 10 und 3 km schwankt.

Im westlichsten Teil von Südkärnten liegt das schluchtenartige Gailtal, das zu beiden Seiten von über 2000 m hohen Gebirgszügen flankiert wird. In seinem unteren Teil befindet sich in einer kesselartigen Verbreiterung der zum grössten Teil versumpfte Pressegger See.

Der Gesteinsuntergrund setzt sich hauptsächlich aus Urgebirge, Carbon und Perm, Trias, Jura sowie jüngeren Tertiärablagerungen zusammen. Das Urgebirge, das hauptsächlich aus kristallinen Schiefern und Gneis besteht, ist in den westlichen Gailtaler Alpen besonders mächtig. Carbon und Permformation kommt in den Karnischen Alpen sowie in den westlichen Karawanken vor. Die östlichen Gailtaler Alpen und Karawanken bestehen dagegen hauptsächlich aus Hauptdolomit und triasischen Kalken, die stellenweise durch Raibler Schichten und erzführende Bleiberger Kalke unterbrochen werden. Die Juraformation, die im östlichen Südkärnten in Form von Gosaukonglomerate n auftritt, ist einerseits in einem schmalen Streifen den östlichen Karawanken vorgelagert, anderseits ragt sie aber auch als kleine Insel am Gazarkaberge mitten im Tale aus den jüngeren Tertiärablagerungen hervor. Unter den losen Ablagerungen sind vor allem die glazialen Moränen und postglazialen Aufschüttungen zu erwähnen. Erstere kann man im Haupttal im Bereiche der ganzen Sohle genau verfolgen, während letztere in grösseren Ausmasse nur am Fusse des Dobratsches im östlichen Gailtal zu finden sind. Torfmoore finden sich am Gösselsdorfer und Zablatnig See im östlichen Jauntal sowie am Pressegger See im Gailtal. Die Ablagerungen dieser letzteren können an manchen Stellen eine bedeutende Mächtigkeit erreichen. Die Dicke der Humuslager ist innerhalb der einzelnen Vegetationstypen ungemein verschieden.

Das Klima von Südkärnten zeichnet sich durch relativ kalte Winter und warme, sehr feuchte Sommer aus.

Jahr	41	42	43	44	45	46
Jänner	— 5'0	— 10	— 7'8	— 2'6	— 8'5	— 3'9
Juli	+ 19'1	+ 18'0	+ 18'6	+ 18'5	+ 19'8	+ 19'3

Tab. 1. Die durchschnittliche Jänner und Julitemperatur von Klagenfurt während der Jahre 1941—46.

Jahr	41	42	43	44	45	46
tiefste Temperatur	— 21'5	— 27'0	— 21'4	— 13'8	— 24'2	— 15'2
höchste Temperatur	+ 30'9	+ 30'4	+ 33'8	+ 33'2	+ 32'6	+ 32'2

Tab. 2. Die tiefste und höchste Jahrestemperatur in Klagenfurt in den Jahren 1941—46.

Die Zahl der Frosttage schwankt in Südkärnten zwischen 130 und 140 im Jahr. Die durchschnittliche Niederschlagshöhe beträgt im Gebiete nördlich der Drau im Jänner 38 mm, im Juli 114, im August 128. Diese Werte liegen jedoch in den Gebieten südlich der Drau erheblich höher. Die thermophilen Lokalitäten und zwar besonders die der südexponierten Bergabhänge besitzen nun vor allem eine viel mildere Wintertemperatur als ihre Umgebung. Wie gross hierbei die auftretenden Gegensätze sein können zeigen uns folgende zwei Beispiele.

In der Nähe von Unterburg am Klopeinersee gibt es am Nordhang der 700 m hohen Gazarka in cca. 500 m ausgedehnte Fichten und Buchenwälder, während sich am Südhang in der gleichen Höhe thermophile Föhrenwälder, die stellenweise sogar von Eichen und Hartlaubbeständen unterbrochen werden, mit einer ganz typischen wärmeliebenden Fauna befinden. Eine vergleichsweise Untersuchung der Temperatur knapp über dem Erdboden, die ich Anfangs Oktober 1947 durch zehn Tage hindurch durchführte, ergab für den Nordhang um 7 Uhr morgens eine Durchschnittstemperatur von  $-0.3$  Grad, während sie am Südhang zur gleichen Zeit  $+4.6$  Grad betrug.

Im östlichen Gailtal kommt es im Winter stets zur Bildung von Kälteseen. Aus diesem Grunde sinken hier die Temperaturen nächtelang unter  $-18$  Grad. 300 m oberhalb der Talsohle beginnt die thermophile Höhenstufe des Spitzegelsüdhangs deren tiefste Wintertemperatur durchschnittlich  $-5$  Grad beträgt.

In den thermophilen Gebieten Südkärntens lassen sich nach den auftretenden Pflanzengesellschaften folgende Biotope unterscheiden: die thermophilen Föhrenwälder; die thermophilen Buschbestände, die sich stellenweise auflösen und in Heiden und Hutweiden übergehen; schliesslich die thermophile Kultursteppe, zu der auch Ruderalstellen, Acker und Wegraine gerechnet werden. Alle diese Lebensgemeinschaften haben einen eigenen Charakter und eigene, für sie typische thermophile Tierformen, bedürfen also im Folgenden einer gesonderten Besprechung. Wir wenden uns nun der ersten der genannten Biozöosen zu, es ist dies

a) Der thermophile Föhrenwald.

Thermophile Föhrenwälder finden wir in der Ebene des Jaun- und Rosentales als kleine, geschlossene, oft auch von Laubhölzern und Gebüschern unterbrochene Waldbestände. Im Vellach und Gailtal treten sie dagegen fast ausschliesslich als lichte Bestände an mehr oder weniger steilen südexponierten Berghängen auf. Beide Formen der thermophilen Föhrenwälder haben nun eine zwar tierarme, aber doch sehr typische Fauna, die neben gemeinsamen Arten, die in der überwiegenden Mehrheit vorhanden sind, doch auch einige für die Föhrenbestände der Bergabhänge charakteristische Formen aufweist, welche in den Wäldern der Ebene anscheinend fehlen.

Der lichte thermophile Föhrenwald der Ebene mit eingesprengten sonnigen Grasplätzen und einzelnen Eichenbeständen, beherbergt ein ziemlich reiches Tierleben, wobei die Insekten das grösste Kontingent stellen. Von charakteristischen Coleopteren dieser Wälder seien nur genannt: *\*Harpalus fuscicornis* Men.<sup>1</sup>, *Licinus cassideus* Fabr., *Dicerca berolinensis* Hbst., *D. moesta* Fabr., *Phaenops cyanea* F., *Buprestis 9 maculata* L., *B. 8 guttata* L., *Chrysobothris Solieri* Cast., *Zonitis immaculata* Oliv., *Amphimallon assimilis* v. *Burmeisteri* Brske., *Cryptocephalus Schäfferi* Schäf., *Polydrosus viridicinctus* Gyll., *\*Rhynchites praeustus* Boh., *Lixus algirus* L.

Die Bodenfauna dieser Wälder ist äusserst artenarm. Einigermassen typisch ist nur *Ctenistes palpalis* Reichenb. Von thermophilen Schneckenarten findet man hier *Zebrina detrita* Müll.

<sup>1</sup> Die mit \* bezeichneten Arten waren bis jetzt aus Kärnten nicht bekannt.

Die lichten Föhrenbestände der steilen Bergabhänge besitzen neben den genannten noch folgende Arten: *Vipera ammodytes* Laur., *Lacerta viridis* L., *muralis* Laur., *Euscorpio germanus* C. L. Koch, *Scolopendra cingulata* Latr., *Satrapes Sartorii* Redtb., *Dimer elateroides* Charp. Kaum weniger eigenartig als die eben geschilderte Biozönose ist eine zweite:

b) Die thermophilen Strauchheiden und Grassteppen.

Obwohl die thermophilen Strauchheiden und Grassteppen eigentlich zwei getrennte Biozönosen darstellen, ziehe ich es vor sie hier gemeinsam zu behandeln, da es, infolge ihrer geringen Ausdehnung und des damit verbundenen gemischten Auftretens, im Gebiete von Südkärnten gänzlich unmöglich ist eine scharfe faunistische Trennung zwischen ihnen durchzuführen. Thermophile Strauchheiden kommen in Südkärnten nur auf leicht nach Süden oder Südosten geneigten Abhängen vor und sind stets lokalisiert. Infolge ihres sehr günstigen klimatischen Charakters besitzen sie eine sehr üppige Fauna und Flora. Unter den Sträuchern dominieren die Eichen- und Hartlaubmischbestände, welche stellenweise auch in kurzgrasige Grassteppen mit eingesprengten Wacholder-;r-büschen übergehen. Reine kurzgrasige Grassteppen, welche nicht im Gefolge von Strauchheiden auftreten, kenne ich nur aus der Umgebung von Ferolach und St. Stephan im östlichen Gailtal; deren Fauna werde ich jedoch getrennt behandeln.

Für die Fauna der Strauchheiden ist es typisch, dass sie besonders reich ist an stenophagen, pflanzenfressenden Insekten. Die grosse Zahl eigentümlicher Pflanzen ermöglicht einer grossen Anzahl wärmeliebender Nahrungsspezialisten, die sonst nirgends in Südkärnten gefunden worden sind, das Fortkommen. Dagegen ist die sublapidicole Fauna dieser Lokalitäten im Gegensatz zu der der isolierten kurzgrasigen Grassteppen des Gailtales auffällig arm an Arten. Von Coleopteren gibt es kaum eine typische Art, am ehesten wären es noch *Licinus cassideus* Fab. und *Formicomus pedestris* Rossi, die aber beide auch in der Kultursteppe vorkommen. Reicher ist hier die Ameisenfauna. Manche Abhänge, besonders dort wo viele flache Steine herumliegen, sind besät mit Ameisenkolonien. Mit ihren Gastameisen scheinen auch gewisse Ameisengäste auf diese Lokalitäten beschränkt zu sein. So findet man in den Bauten einer *Formica spec.* bei Mökriach *Myrmecoxenus subterraneus* Chev., *Euconnus claviger* Müll., *Ptenidium myrmecophilum* Motsch. (Das typische *Pt. myrmecophilum* scheint an der Drau seine österreichische Nordgrenze zu erreichen, da sämtliche Stücke, die ich bis jetzt aus der Wiener Gegend erhielt einer anderen mit dieser konfundierten Art angehören. In Südkärnten lebt *Pt. myrmecophilum* ausschliesslich auf thermophilen Lokalitäten bei Ameisen. Stücke, die ich bei Unterburg und St. Kanzian in Kompost sammelte, gehören ebenfalls der zweiten Art an.). \**Catopomorphus arenarius* Hampe, den ich bis jetzt nur vom Gazarka Südhang kenne, lebt bei einer *Messor* Art. Wenn nun auch die Ameisen zu geringerer Zahl ausserhalb dieser Biotope leben, so scheinen die Käfer selbst aus mikroklimatischen Gründen und wohl auch infolge ihrer Bindung an grössere Bestände ihrer Wirtsameisen absolut an dieses Biotop gebunden zu sein. Leider ist aber gerade über die myrmecophilen Coleopteren der thermophilen Strauchheiden Südkärntens bis jetzt fast gar nichts bekannt geworden und auch ich besitze viel zu wenig Material um irgend etwas sicheres darüber aussagen zu können.

Von den sonstigen Bodentieren sind hier besonders die Bewohner der faulenden Laublagen unter den Sträuchern zu erwähnen. Hier finden sich folgende sehr charakteristische thermophile Arten, die bis jetzt in Südkärnten ausschliesslich in diesem Biotop gefunden wurden: *Corticarina fulvipes* Com., *Atomaria scutellaris* Motsch., \**Dasycerus jonicus* Reitt. (Die Identität mit dieser Art wurde durch vergleichend ana-

tomische Untersuchung von griechischen Stücken sichergestellt.), \**Alexia* nov. spec. (prope *corcyrea*), *Laena viennensis* Sturm. Weiters lebt hier der Pseudoscorpion *Neobisium Doderöi* Beier und der Regenwurm *Helodrilus tellinii* Rosa, zwei Arten die zwar nicht immer extrem thermophil zu sein scheinen, aber ihrer Verbreitung nach als südlich angesprochen werden müssen.

Unter den zahlreichen Phytophagen dieses Biotopes nehmen die Coleopteren die erste Stelle ein. Das nachfolgende Verzeichnis enthält eine Liste aller, von mir bis jetzt in diesem Biotop aufgefundenen, typisch thermophilen Käferarten. Ein vollständiges Verzeichnis kann allerdings beim heutigen Stand der Erforschung Südkärntens noch nicht gegeben werden. Charaktertiere der thermophilen Strauchheiden sind: *Selatosomus depressus* Germ., *Melanotus crassicornis* Er., *Qasimus minutissimus* Germ., *Idolus picipennis* Bach., \**Agrilus roscidus* Kiesw., *Cylindromorphus filum* Gyll., *Malthinus fasciatus* Ol., \**Colotes maculatus* Lap., *Hyphaeus flavicornis* Er., \**Cyrtosus cyanipennis* Er., *Malachius inornatus* Küst., \**Mordellistena episternalis* Muls., *Lytta vesicatoria* L., *Zonabris variabilis* Pallas., *Zonitis immaculata* Ol., *Rhipiphorus paradoxus* L., \**Oedemera cyanescens* Schmidt., \**Agapanthia cynarae* Germ., *Phytoecia uncinata* Redtb., \**Obera euphorbiae* Germ., *Labidostomis pallidipennis* Gebl., *Lachnea sexpunctata* Scop., \*italica Weise., *Cryptocephalus elegantulus* Grav., *strigosus* Germ., *elongatus* Germ., *Schäfferi* Schäf., *Pachybrachis fimbriolatus* Suffr., *Chrysomela salviae* Germ., *Aphthona herbigrada* Curtis, *Dibolia rugulosa* Redtb., *Baris Villae* Com., \**Rhynchites aethiops* Bach.

Die isolierten kurzgrasigen Steppen des östlichen Gailtales, welche als Hutweiden genutzt werden, beherbergen folgende mehr oder weniger wärmeliebende Coleopteren: *Harpalus fuscicornis* Men., *dimidiatus* Rossi., *Ophonus azureus* F., *Licinus cassideus* F., *Emus hirtus* L., *Ablattaria laevigata* F., *Saprinus aeneus* F., *Sisyphus Schäfferi* L., *Onthophagus austriacus* Panz., *Oniticellus fulvus* Goeze., *Aphodius scrutator* Hrbst., *Heptaulacus testudinarius* F., *Rhizotrogus aestivus* Ol., *Chrysomela limbata* F., *marginata* L., *carnifex* F., *Euscorpio germanus* C. L. Koch, *Zebrina detrita* Müll.

Wir kommen nun zum dritten Biotop, es ist das

c) Die thermophile Kultursteppe.

Das Kulturland in den thermophilen Gebieten Südkärntens ist äusserst vielgestaltig und demgemäss auch seine Fauna sehr stark wechselnd. Die relativ selten durch den Menschen veränderten Grasflächen wie Raine, Eisenbahndämme, Schottergruben und die Grasnarbe am Fusse von Mauern besitzen folgende charakteristische Coleopterenfauna: *Harpalus dimidiatus* Rossi., *Roubali* Schaub., *smaragdinus* Duft., *honestus* Duft., *Ophonus rufibarbis* F., *punctatulus* Duft., *puncticornis* Payk., *signaticornis* Duft., \**Oodes gracilis* Villa., *Microlestes maurus* Sturm., *plagiatus* Duft., *Brachynus crepitans* L., *explodens* Duft., *Formicomus pedestris* Rossi., *Anthicus quadriguttatus* Rossi., *hispidus* Rossi., *Meloe autumnalis* Ol., *brevicornis* Panz., *Blaps gigas* L., \**lethifera* Marsh., *mortisaga* L., *mucronata* Latr., *Opatrum sabulosum* L., *Cryptocephalus elegantulus* Grav., \**Bruchidius marginalis* F., \**unicolor* Ol.<sup>1</sup> Ferner leben an solchen Stellen nicht selten die Isopoden: *Metoponorthus pruinosis* Brdt., *Cylisticus convexus* De Geer., *Armadillidium versicolor* *qinqeseriatum* Verh. und schliesslich die Regenwürmer *Allolob-*

<sup>1</sup> *Otiorrhynchus crataegi* Germ. wurde von mir im Jahre 1949 in Südkärnten an den verschiedensten Stellen nachgewiesen. Diese südöstliche Art findet sich im ganzen Gebiet nicht selten als Kulturfolger in Hausgärten auf Fliederbüschen. Nordwärts reicht sie bis Norddeutschland und Südschweden.

*Otiorrhynchus velutinus* Germ. sammelte ich im Oktober 1947 bei Eberndorf im Jauntal in grösserer Anzahl auf Ruderalstellen unter Steinen.

*phora caliginosa trapezoides* Ant. Dug., *Octolasion complanatum* Ant. Dug. und *Octolasion mima* Rosa.

Ein etwas anderes Bild bieten uns die Weingärten, die aber in Südkärnten nur in sehr beschränkter Ausdehnung bei Sittersdorf und Mökriach vorkommen. Neben den schon vorher genannten Arten finden sich hier noch *\*Gnaptor spinimanus* Pall., *\*Gonocephalum pygmaeum* Stev., *Mantis religiosa* L., *Lacerta muralis* Laur. und *viridis* L. Unter Steinen und zwischen Graswurzeln lebt hier *Ctenistes palpalis* Reichenb.

Eigenartig ist das Faunenbild der landwirtschaftlich genutzten Flächen. Die ihr angehörigen Tiere sind durch eine besondere Anpassungs- und Wanderfähigkeit ausgezeichnet, eine Eigenschaft, der sie in diesem am meisten periodischen Veränderungen unterworfenen Biotop unbedingt bedürfen. Daher dominieren hier unter den Colopteren die Carabiden. So findet man: *Carabus Germari* Sturm., *granulatus interstitialis* Duftschm., *cancellatus nigricornis* Dej. *Nothiophilus substriatus* Waterh., *\*Pterostichus Koyi garicianus* Müll., *\*Leonisii* Apfb., *melas* Creutz., *Abax carinatus porcatus* Duftschm., *Amara rufipes* Dej., *\*sabulosa* Serv., *\*Zabrus piger* Dej., *Harpalus tenebrosus* Dej., *Badister unipustulatus* Bon., *\*Licinus silphoides* Rossi, *\*Brachinus Ganglbaueri* Apfelb., *\*Platyscelis polita* Strm. (In Maispflanzungen), *Formicomus pedestris* Rossi., *\*Omophlus picipes* Fabr., *\*Anisoplia lata* Er., *segetum* Hbst.

Die soziologische Analyse der thermophilen Faunenelemente Südkärntens zeigt, dass sich die wärmeliebenden Arten in der überwiegenden Mehrzahl in ausgesprochen sonnigen, baumfreien oder zumindest baumarmen Biotopen konzentrieren. Sie finden sich in den lichten Föhrenwäldern, in der Strauchheide und in der Kultursteppe. Wo dichter Waldbestand den Sonnenstrahlen den Zutritt zum Erdboden verwehrt, finden sich stets nur äusserst wenige wärmeliebende Formen. Demnach kann man die thermophile Fauna Südkärntens ganz allgemein als eine Fauna der sonnigen Biotope bezeichnen und es steht ausser Zweifel, dass einer ihrer grössten natürlichen Feinde der allerdings selbst wieder klimabedingte Wald ist.

Die thermophile Fauna Südkärntens ist zum grössten Teil ursprünglich. Die an wärmeliebenden Tieren reichen Biotope weisen alle Kennzeichen ursprünglicher Tier- und Pflanzengesellschaften auf und selbst die Tiere der Kultursteppe lassen zum Teil erkennen, dass sie nicht mit dem Menschen eingewandert, sondern aus primären Biotopen sekundär in die vom Menschen neugeschaffenen Lebensräume eingedrungen sind. Zweifellos müssen manche Formen, wie z. B. die Tenebrioniden *Gnaptor spinimanus*, *Blaps gigas*, *lethifera*, *Gonocephalum pygmaeum*, *Platyscelis polita*, sowie die Asseln *Metoponorthus pruinosus*, *Cylisticus convexus* und *Armadillidium versicolor qingeseriatum*, alles Arten, die bis jetzt in Südkärnten ausschliesslich in der nächsten Umgebung von menschlichen Behausungen oder in diesen selbst aufgefunden wurden und sich infolge ihrer Lebensweise vorzüglich zur Verschleppung eignen, als importiert angesprochen werden<sup>2</sup>. Diese eingeschleppten Formen sind jedoch in verschwindender Minderheit gegenüber der grossen Zahl autochthoner Arten (Vergleiche auch Franz in Zoogeographica III. p. 227).

Betrachtet man die Gesamtverbreitung der thermophilen Fauna Südkärntens, so fällt einem sofort das fast vollständige Fehlen der pontisch-pannonischen Formen auf. Selbst die wenigen pontomediterranen Arten, welche bis jetzt in Südkärnten aufgefunden wurden, zählen nicht zur autochthonen Fauna sondern sind ausnahmslos durch den Menschen importiert worden und leben im Gebiete ausschliesslich in der nächsten

<sup>2</sup> Auch *Harpalus Roubali*, *Zabrus piger* und *Amara sabulosa* sind wahrscheinlich durch den Menschen importiert worden.



Umgebung von menschlichen Ansiedelungen. Das Fehlen aller dieser Steppenbewohner hängt mit der hohen jährlichen Niederschlagsmenge Südkärntens zusammen, welche ihnen als typische Trockentiere nicht zusagt.

Die Westgrenze ihrer Verbreitung erreichen in Südkärnten, nach dem jetzigen Stand unserer Kenntnisse: *Carabus Germari typ.*, *granulatus interstitialis*, *cancellatus nigricornis*, *Ptenidium myrmecophilum*, *Dasyceus ionicus*, *Alexia spec.*, *Gnaptor spinimanus*, *Brachynus gangebaueri*, *Blaps gigas*, *Helodrilus tellinii*, *Octolasion mima*, *complatum*, *Platyscelis polita*.

Im Gebiete selbst können wir eine stufenweise Verarmung gegen das Alpeninnere zu feststellen. Der an thermophilen Tieren reichste Teil Südkärntens ist das östliche Jauntal. Es gibt nur eine einzige Art in ganz Südkärnten, die bis jetzt in dieser Gegend nicht gefunden wurde, es ist dies *Bruchidius marginalis* F. Bei einer genaueren Erforschung des östlichen Jauntales wird man aber in Hinkunft damit rechnen müssen, dass auch diese Art daselbst aufgefunden werden wird. Schon im Gebiete des Faaker Sees fehlt eine grössere Anzahl von thermophilen Arten, welche im östlichen Jauntal noch häufig gefunden werden, gar nicht zu reden von denjenigen pontomediterranen Elementen, die wie z. B. *Blaps gigas*, durch den Menschen importiert wurden. Im östlichen Gailtal finden wir nur noch eine artenmässig sehr arme thermophile Fauna vor, von der die meisten Formen westlich des Gitschtales auslöschen. Aus dem Gebiete westlich des Gitschtales ist mir nur noch *Cryptocephalus elegantulus* Grav. aus der Umgebung von Kötschach-Mauter. bekannt geworden.

Zusammenfassend kann man feststellen, dass die thermophilen Gebiete von Südkärnten eine zahlenmässig sehr reiche wärmeliebende Fauna besitzen, die in ihrem Wesen vollkommen der Fauna, der analogen Gebiete, in Slovenien und dem westlichen Oberitalien gleicht.

Infolge der klimatischen Verhältnisse finden wir in der autochthonen, thermophilen Fauna ausschliesslich mediterrane und illyrische Arten, während pontische Elemente fast vollständig fehlen. Im Zusammenhange damit kann man im Gebiete selbst eine, in drei Stufen vor sich gehende, Verarmung der wärmeliebenden Fauna gegen das Alpeninnere zu feststellen.

Während die meisten Arten von mediterraner und illyrischer Provenienz in Südkärnten ausgesprochene Kulturflüchter sind, ist das Auftreten der wenigen pontisch-pannonischen Formen, die man bis jetzt hier auffand, stets mit Kulturfolge verbunden.

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## DER EINFLUSS DER EINZEIT AUF DIE VERBREITUNG DER OSTALPINEN TRECHUSARTEN

Von *Harald Schweiger*

Die *Trechini* zählen wohl zu den geeignetsten Formen, um die Spuren der Eiszeit in der Fauna der Alpen zu demonstrieren. Alle hoch- und subalpinen Vertreter dieser Carabidentribus sind ungeflügelt und besitzen infolge ihrer geringen Grösse und besonderen Lebensweise nur eine sehr beschränkte Migrationsfähigkeit, so dass ihr Verbreitungsgebiet seit dem Ende der Eiszeit nur sehr wenig verändert wurde. Daher zeigen uns auch die rezenten Verbreitungsbilder der hochalpinen Trechusarten die hohe Bedeutung, die die Massifs de refuge zur Zeit der stärksten Vergletscherung für die autochthone Gebirgsfauna besaßen. Als Massifs de refuge bezeichnet man bekanntlich jene randlichen Teile der Alpen, welche während der ganzen Eiszeit unvergletschert blieben und daher auch während der Zeiten stärkster Vergletscherung für die autochthone Gebirgsfauna einen Zufluchtsort darstellten, in welchem diese die Eiszeit überdauern konnte. Die Randzone der Massifs de refuge beherbergt daher eine grosse Zahl von endemischen und stenotopen Arten, während in der devastierten Zone solche endemische Arten vollständig fehlen. Diese Tatsache findet darin ihre Erklärung, dass sich in postglazialer Zeit viele schwer bewegliche und in ökologischer Hinsicht besonders anspruchsvolle Arten an der Rückwanderung in das eisfrei werdende Gebiet nicht zu beteiligen vermochten und daher noch in der Gegenwart auf die eiszeitlichen Zufluchtsorte beschränkt sind.

Für die typisch hochalpinen Trechusarten ist es hiebei charakteristisch, dass in den zentralen, während der Eiszeit stark vergletscherten Alpentellen in der Gegenwart auf weiteste Erstreckung kein einziger Vertreter dieser Gruppe vorhanden ist, während die ringförmig um die Alpen gelagerte Randzone der Massifs de refuge eine ganz beträchtliche Anzahl von Arten beherbergt (Karte I.). Diese Verhältnisse wurden von Schönmann genau untersucht und es sei hier auf die von ihm veröffentlichte Verbreitungskarte besonders verwiesen (Zool. Jahrb. Syst. Vol. 70, p. 178, Jena 1937).

Ganz anders liegen nun die Verhältnisse bei den subalpinen Arten. Da manche von ihnen viel weniger spezielle ökologische Ansprüche stellen als die hochalpinen Formen, sind sie viel migrationsfähiger und konnten daher in postglazialer Zeit grössere Teile des vollständig devastierten Gebietes der zentralen Ostalpen wieder besiedeln (Karte 2.).

So sind *Tr. alpicola* und *limacodes*, die sowohl sub- als auch hochalpin zu leben vermögen, über das gesamte Gebiet der Ostalpen zwischen Grossglockner im Westen und Rax im Osten verbreitet. Durch diese weite Verbreitung sind diese beiden Arten auf vielen Berggipfeln des zentralen Gebietes der Ostalpen die einzigen Vertreter der Gattung *Trechus*. Die Westgrenze ihres Vorkommens verläuft bei diesen beiden Arten ungefähr vom Tarnovener Wald über den Krn und Triglav zum Hochstuhl in den Karawanken; nördlich der Gail springt diese Grenze etwas nach Westen vor und wird im Folgenden durch die Fundplätze im Dorfer Tal und in der Glockner Gruppe bezeichnet. Im Gebiete der Nordalpen wurde *Tr. alpicola* westlich des Ennsflusses bis jetzt nur an zwei Stellen am Tamischbachturm in den Gesäusealpen aufgefunden, während *Tr. limacodes* noch am Südabfall des Dachsteinmassifs vorkommt. Nördlich der Donau kommt *Tr. alpicola* als einzige ostalpine Trechusart im Gebiete der Böh-

mischen Masse und im Waldviertel vor. Eine geographische Rasse von *Tr. alpicola* lebt in Bosnien auf der Trebevic Planina, Bjelasnica Planina und Vranica Planina. Die von Jeannel zitierten Fundorte von *Tr. limacodes* aus dem Trentino (L'Abeille, Vol. 33, p. 515) sind unrichtig und dürften auf Fundortsverwechslungen zurückzuführen sein (Karte 3.).

Die Wiederbesiedelung der devastierten Zone erfolgte bei *Tr. alpicola* und *limacodes*, welche beide die Eiszeit auf den ringförmig um die Zentralalpen gelagerten Massifs de refuge überdauerten, von allen Seiten zugleich. Durch diese Rückwanderung von verschiedenen Seiten kam es in postglazialer Zeit zu einer vollständigen Vermischung der verschiedenen Populationen, weshalb es bei diesen Arten gänzlich unmöglich ist, irgendwelche geographische Rassen zu unterscheiden.

*Tr. rotundipennis* ist eine Art, deren Verbreitung ringförmig um die zentralen Ostalpen verläuft. Nördlich des Alpenhauptkammes geht *Tr. rotundipennis* viel weiter nach Westen als irgendeine andere subalpine Trechusart. Seine Westgrenze verläuft hier auf der Linie Gerlos-Pass, Schmittenhöhe, Loferer Steinberge, Untersberg. Dem Laufe der Täler folgend dringt diese Art stellenweise, so z. B. bei Gastein, sehr tief in das innere der Zentralalpen ein. Das merkwürdige rezente Verbreitungsbild (Karte 4.) entstand dadurch, dass *Th. rotundipennis* in postglazialer Zeit den Hauptkamm der Zentralalpen infolge seiner Lebensweise, es handelt sich hierbei um einen ausgesprochenen Bewohner der subalpinen Wälder, an keiner Stelle zu überschreiten vermochte, während er sich gleichzeitig zu beiden Seiten derselben sehr weit ausbreitete.

Sowohl in der östlichen als auch südlichen Randzone der Ostalpen kommen stenotope subalpine Trechusarten vor (Karte 5.). So wurde *Tr. grandis*, der an subalpinen Quellrieseln unter Steinen, aber auch im ständig von Wasser übersprühten Moos lebt, bis jetzt nur auf der Koralpe gefunden.

Der mit *Tr. grandis* auf Grund anatomischer Merkmale nächstverwandte *Tr. longicollis*, der in je einer endemischen Rasse auf dem Zirbitzkogel, der Saualpe und dem Bachergebirge zu finden ist, führt eine ähnliche Lebensweise.

Besonders auffällig sind nun die Verhältnisse in der südlichen Randzone. Hier finden wir stenotope subalpine Trechusarten zunächst im Osten, im Gebiete der Julischen Alpen, wo sie mit einigen weit verbreiteten Arten, wie *Tr. alpicola* und *croaticus*, zusammen vorkommen und dann noch auf einem sehr schmalen Streifen im Westen der Randzone. Beide Gebiete werden jedoch durch eine breite Lücke, in der nicht eine einzige subalpine Trechusart vorkommt, vollständig getrennt. Diese Lücke umfasst das gesamte Gebiet der Karnischen-Alpen, sowie einen grossen Teil der Venetianer-Alpen. (Vergl. auch Karte 2.).

Die Verbreitung der stenotopen subalpinen Trechusarten im Gebiet der südlichen Ostalpen ist von Osten nach Westen gehend folgende:

*Tr. carniolae* J. Müll.: Pokljuka (Pretner), Otoce (v. Gspann).

— *gracilitarsis* Daniel: Mte. Cavallo (Moczarski, Holdhaus), Mte. Grappa (Breit), Oliero (Dodero), Mte. Zebio (v. Troll). Der Fundort Val di Ledro (Ganglbauer) ist unrichtig. Es liegt offenbar eine Fundortsverwechslung vor.

— *silvicola* Daniel: Campo Grosso (Holdhaus), Piano della Fugazza (Daniel), Mte. Pasubio (Pecoud).

— *bergmascus* Jeann.: Val di Ledro (Ganglbauer), Osteria di Campolaro im Adamellogebiet (Breit), Mte. Guglielmo (Breit), Val Sorino (Pechlaner).

Zusammenfassend kann man nun feststellen, dass die Gattung *Trechus* und zwar besonders die hochalpinen Arten einwandfrei zeigen, dass die Zone der Massifs de

refuge während der Eiszeit den einzig bewohnbaren Lebensraum für die hoch- und subalpinen Insekten gebildet hat. In dieser Zone haben die hochalpinen und zum Teil auch subalpinen Insekten die Eiszeit überdauert, während sie in den vom Eise bedeckten Gebieten vollständig vernichtet wurden. Nur so ist der auffallende Artenreichtum der Massifs de refuge gegenüber der devastierten Zone zu erklären.

In ihrer rezenten Gesamtverbreitung spiegeln die hochalpinen Vertreter der *Trechini* das Vordringen der Eismassen in ihren Lebensraum wider. Sie zeigen, welche furchtbare Katastrophe die Eiszeit für die autochthone Gebirgsfauna gebildet hat. Die grosse Lücke im Inneren der Ostalpen und die eigentümlichen Grenzen ihrer rezenten Verbreitung wurden durch die Eiszeit verursacht und sind bis zum heutigen Tage fast unverändert erhalten geblieben.

Bei den subalpinen Arten konnten dagegen einige, in der östlichen Hälfte der Nord- und Zentralalpen, grosse Teile des devastierten Gebietes wiederbesiedeln. Hier verläuft die genaue Westgrenze des Gebietes, in dem wir subalpine Trechusarten finden, vom Untersberg bei Salzburg über die Loferer Steinberge zum Gerlos-Pass, der der westlichste Fundort einer subalpinen Trechusart im Gebiet der Zentralalpen überhaupt ist. Südlich des Gerlos-Passes verlagert sich diese Grenze allmählich nach Osten und geht entlang des Kalser Tales und der Glockner Gruppe zu den südlichen Bergen der Kreuzeck Gruppe. Von hier führt sie dann über die Latschur zum Spitzegel in den Gailtaler Alpen. (Vergl. Karte 2.).

In den Südalpen finden wir subalpine Trechusarten einerseits in einem geschlossenen und wohlungrenzten Gebiet im Osten, anderseits aber auch in der westlichen Hälfte in einem langgestreckten, schmalen nur auf die äusserste südliche Randzone beschränkten Streifen, der vom Lago d'Iseo im Westen über das südliche Adamellogebiet, den Mte. Pasubio und Mte. Grappa zum Mte. Cavallo im Osten reicht. Die Westgrenze des östlichen Gebietes verläuft vom Tarnovaner Wald über den Krn und Triglav in den Julischen Alpen zum Hochstuhl in den Karawanken. Zwischen Krn und Mte. Cavallo klafft eine breite Lücke, in der bis jetzt keine einzige subalpine Trechusart aufgefunden wurde. Alle im Westteil der südlichen Ostalpen vorkommenden subalpinen Trechusarten konnten ihr auf die äusserste Randzone beschränktes Wohngebiet an keiner Stelle postglazial ausweiten. (Vergl. Karte 2 und 5.). Dadurch kommt es, dass wir hier weiter im Inneren, im Gegensatz zur östlichen Hälfte der Alpen, hochalpine Trechusarten noch auf Bergen finden, auf denen subalpine bereits vollständig fehlen. Als weitere Folge davon gibt es in den westlichen Ostalpen weite Gebiete, in denen nicht ein einziger hoch- oder subalpiner Vertreter der *Trechini* vorkommt. Der Grund für alle diese Erscheinungen dürfte in der stärkeren Vereisung dieses Gebietes zu suchen sein, deren Folgen sich ja auf die hochalpinen Arten naturgemäss viel weniger stark auswirkten als auf die subalpinen. Das Phänomen des Fehlens jeglicher subalpinen Trechusart in den westlichsten Karawanken, Karnischen- und grossen Teilen der Venetianer Alpen kann derzeit nur als Tatsache festgestellt werden. Eine befriedigende Erklärung hierfür wird jedoch erst zu einem späteren Zeitpunkte, an Hand von ähnlichen Verbreitungsbildern, möglich sein.

Im Anschluss an meine zoogeographischen Ausführungen gebe ich noch eine kurze Beschreibung von einigen von mir als neu ausgewiesenen Trechusformen.

*Trechus longicollis slovenicus* nov. ssp.

*Tr. grandis* und *Tr. longicollis* sind auf Grund ihrer vollständig verschiedenen Innensackauszeichnung als zwei verschiedene Arten aufzufassen (Abb. 1 und 2).

Vom Habitus des *Tr. grandis*. Kopf gross, samt den Augen breiter als lang. Augen gross etwas vorspringend. Schläfen etwa ein Drittel so lang wie der Längsdurchmesser der Augen, nach hinten ziemlich stark convergierend. Halsschild quer herzförmig, ein Drittel breiter als lang, nach vorne und zu der Wurzel der mässig grossen, scharf spitzwinkelig nach aussen vorspringenden Hinterwinkel gleichmässig gerundet verengt. Flügeldecken kurz, breit eiförmig, ein Drittel länger als breit, etwas hinter der Mitte am breitesten, mässig gewölbt, die Schulterränder sehr flach bogenförmig verrundet, die inneren vier Streifen gleich stark, die äusseren allmählich feiner werdend. Long. 5—5'5 mm.

Typen, I ♂ I ♀, in meiner Sammlung; Bachergebirge Slov. bor., lg. Bernhauer. Verbreitung: Diese Rasse wurde bis jetzt nur aus dem Gebiete des Bachergebirges bekannt und scheint daselbst endemisch zu sein.

Von *Tr. longicollis* s. str. unterscheidet sich diese Form sofort durch den viel breiter als langen Halsschild, den breiteren Kopf und die andere Form der Flügeldecken. Von der ssp. *arcuatus* durch den in der Mitte am breitesten Halsschild und der nach vorne etwas anders verlaufenden Flügeldeckenform.

*Tr. constrictus* Franzi nov. ssp.

Von *Tr. constrictus* s. str. sofort durch grössere und robustere Gestalt dunklere Farbe, abweichende Halsschildform und die etwas andere Form der Ligula zu unterscheiden.

Pechschwarz, das erste Glied der pechbraunen Fühler, Taster und Beine dunkel gelbbraun. Kopf samt den Augen breiter als lang. Schläfen etwa ein Drittel so lang wie der Längsdurchmesser der Augen. Halsschild breit herzförmig, etwas mehr wie ein Drittel breiter als lang in der Mitte am breitesten, nach vorne sowie zur Basis seiner spitzwinkelig vorspringenden Hinterecken gleichmässig gerundet verengt. Flügeldecken eiförmig, in der Mitte am breitesten, wenig gewölbt, die Schulterwinkel flach bogenförmig verrundet. Die Ligula (Abb. 3 und 4), welche vom gleichen Bauschema wie bei der Stammform ist, ist ventral viel weniger stark bauchig erweitert und besitzt eine vollkommen gerade Dorsalkontur. Ihre Spitze ist etwas kürzer als bei der Stammform. Long. 4'5—4'8 mm.

Typen, I ♂ I ♀, in meiner Sammlung; Tappenkar, westliche Radstätter Tauern, lg. Leeder.

Verbreitung: Diese Form ist über die gesamten Gurktaler Alpen, Niedere Tauern und Gesäuse Alpen verbreitet. An ganz wenigen Stellen, z. B. im Königsstuhlgebiet und in der Ingering, finden sich Uebergänge zur Stammform.

*Trechus elegans* Hölzeli nov. ssp. (Winkler i. e.).

Mit *Tr. elegans carniolicus* und *Schusteri* nächstverwandt. Von beiden durch etwas schlankeren Habitus, stets viel hellere Farbe (hell bis dunkel rötlichgelb) und abweichende Penisform zu unterscheiden (Abb. 5).

Der Penis ist mässig dick, gebogen, im basalen Teil deutlich schmaler und ventral stark abgebogen. Die rechte Seitenwand zeigt in der terminalen Hälfte eine kapuzenförmige Emporwölbung von der ungefähren Stärke der ssp. *Schusteri*. Der Apex ist noch etwas länger als bei *carniolicus*, terminal in keiner Weise verdickt und zu seiner verrundeten Spitze fast vollkommen gerade verengt.

Typen, I ♂ I ♀, in meiner Sammlung; Koschuta, Karawanken, Cr. m., lg. Hölzeli. Verbreitung: Diese Rasse wurde bis jetzt nur aus dem Gebiete der Koschuta in den mittleren Karawanken bekannt und scheint daselbst endemisch zu sein.

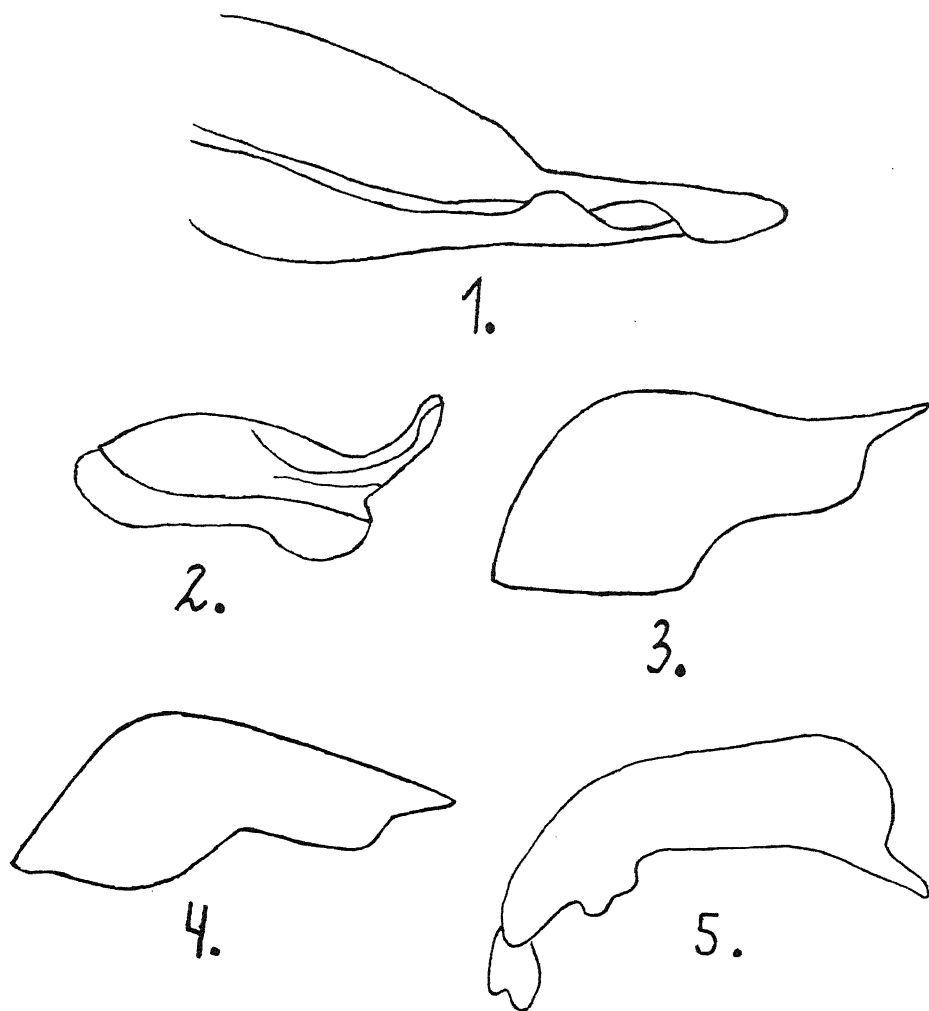
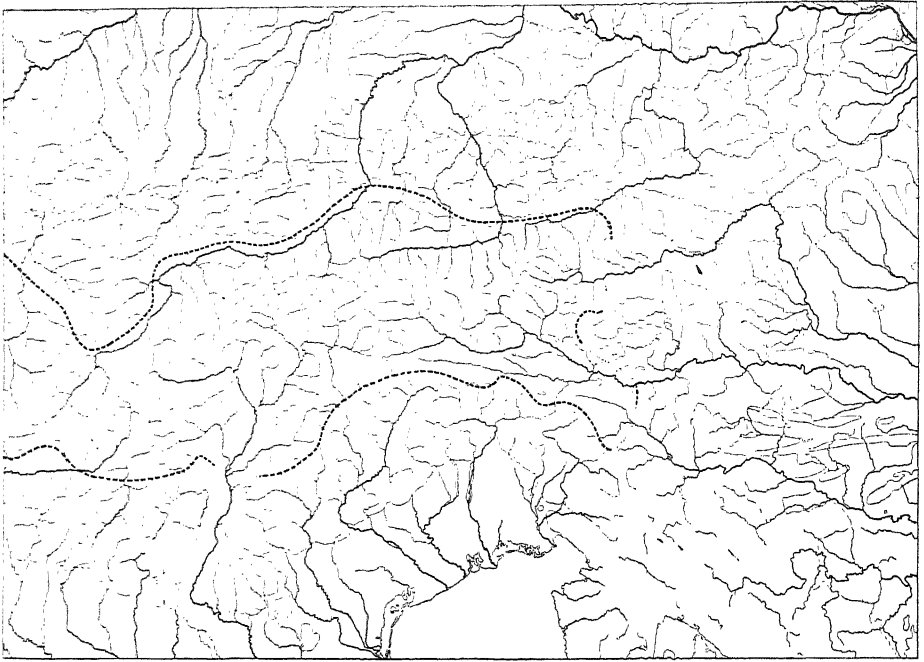
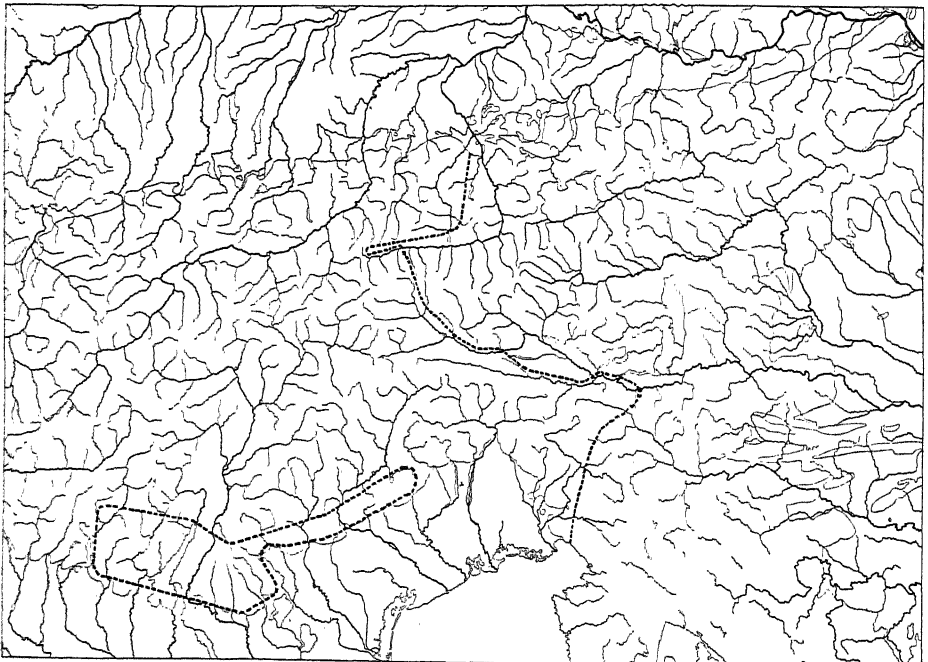


Abb. 1. *Trechus grandis* Ganglb. Ligula in Dorsalansicht (aus dem Innensack herauspräpariert). — Abb. 2. *Tr. grandis* Ganglb., schreibe: Zweites Chitinstück in Lateralansicht (aus dem Innensack herauspräpariert). — Abb. 3. *Tr. constrictus* Schaum form. typ. (Koralpe). Umriss der Ligula in Lateralansicht (aus dem Innensack herauspräpariert). — Abb. 4. *Tr. constrictus* Franzl nov. subsp. (Tappenkar). Umriss der Ligula in Lateralansicht (aus dem Innensack herauspräpariert). — Abb. 5. *Tr. elegans* Hölzeli nov. subsp. Umriss des Kopulationsapparates in Lateralansicht.

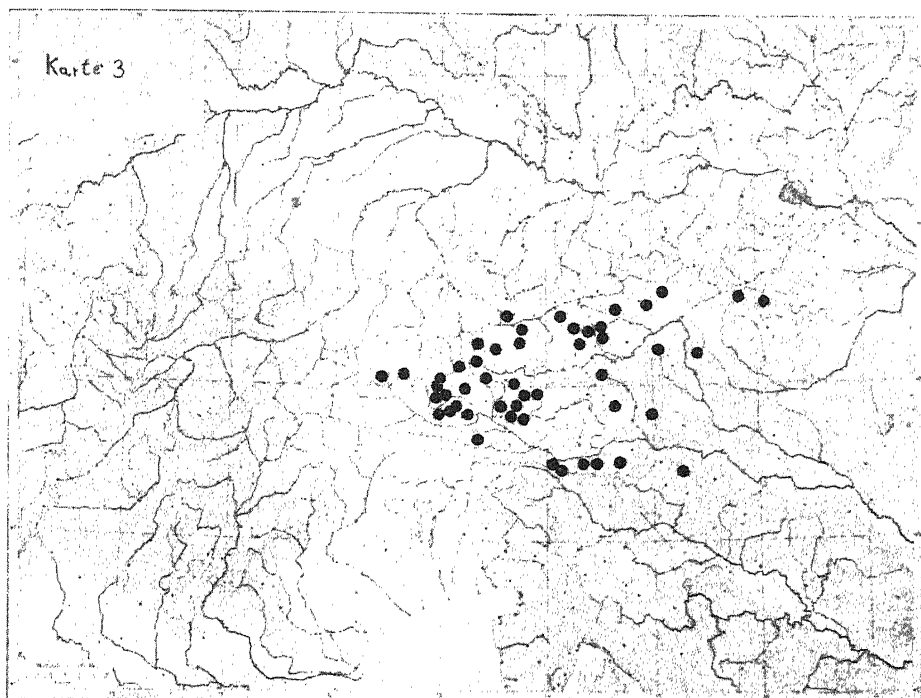


Karte 1. Umgrenzung des zentralen Teiles der Ostalpen ohne typisch hochalpine Trechus-Arten. (Innerhalb der unterbrochenen Linie fehlen typisch hochalpine Trechus-Arten).

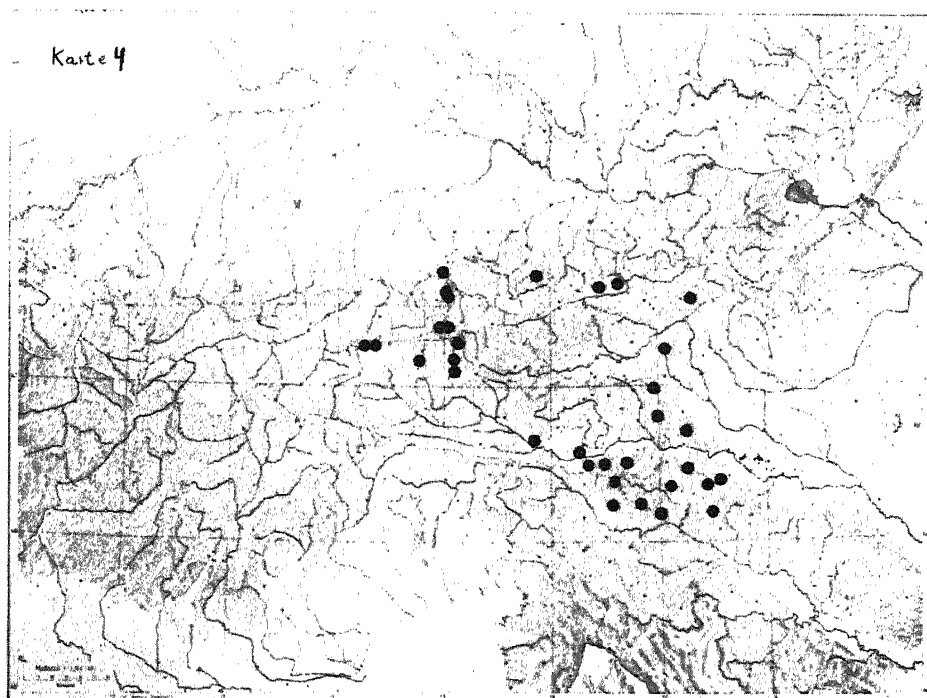


Karte 2. Gesamtverbreitung der subalpinen Trechus-Arten in den Ostalpen (Westlich der unterbrochenen Linie finden sich typisch subalpine Trechus-Arten, nur in dem von der gestrichelten Linie umrandeten inselförmigen Gebiet).

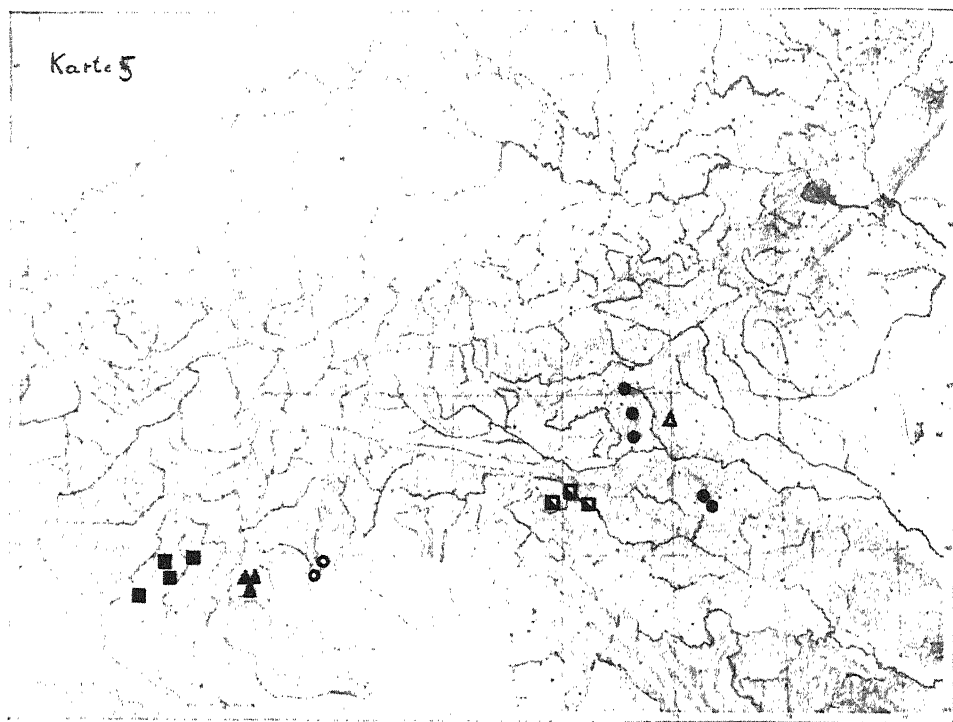




Karte 3. Verbreitung von *Trechus limacodes* Dej.



Karte 4. Verbreitung von *Tr. rotundipennis* Duftschm.



Karte 5. Verbreitung der stenotopen subalpinen Trechus-Arten in den Ostalpen:

- Tr. bergamascus* Jeann. ■  
*Tr. silvicola* K. et J. Daniel ▲  
*Tr. gracilitarsis* K. et J. Daniel ○  
*Tr. carnioliae* J. Müll. ◻  
*Tr. longicollis* Meixn. ●  
*Tr. grandis* Ganglb. △

## DIE COLEOPTEREN-FAUNA DER STORCHNESTER

Von V. Székessy

Neben einer Reihe spezieller Arbeiten über die in Vogelnestern gefundenen Arthropoden kennen wir auch zahlreiche diesbezügliche Hinweise in faunistischen Aufarbeitungen verschiedener Gebiete, sowie in systematischen Monographien. Die Untersuchungen über die Bewohner der Vogelnester sind jedoch viel geringer an Zahl und auch meist viel weniger eingehend als die über Säugetiernerster. Dieser Umstand mag nun seinen Hauptgrund wohl darin finden, dass die Säugetiernerster oftmals ausgezeichnete Möglichkeiten zur Entdeckung neuer Arten bieten, während dies bei Vogelnestern bedeutend weniger häufig der Fall ist. Den Gegenstand biologisch-ökologischer Untersuchungen beginnen die Vogelnester jedoch erst in den letzten Jahren zu bilden, usw. in den Arbeiten von Lehnert (1933), Nordberg (1936) und Sick (1940). Über den weissen Storch (*Ciconia ciconia* L.) gibt es aber in allen diesen Arbeiten nur äusserst spärliche Angaben. So meldet Bickhardt (1911) aus Storchnestern insgesamt 4 und Weber (1938) aus einem abgestürzten Storchnest 13 Coleopteren-Arten. Das Nest des weissen Storches erscheint aber gerade infolge seiner Grösse und Bauweise, sowie hauptsächlich seiner von der näheren Umgebung scharf isolierten Anlage für ökologische Untersuchungen sehr geeignet. Deshalb begann ich 1943 mit der Untersuchung der Nester dieses Charaktervogels des ungarischen Tieflandes und berichtete im Jahre 1944 über die vorläufigen Ergebnisse aus drei Storchnestern. Im weiteren will ich nun eine Zusammenfassung meiner bisherigen Untersuchungen an 7 verschiedenen Storchnestern vorlegen, von welchen eines zu 5 verschiedenen Zeitpunkten untersucht wurde, ein weiteres zu 2 verschiedenen Zeitpunkten und die übrigen 5 je einmal.

Die Anlage des Storchnestes erfolgt möglichst frei und hoch, auf Hausdächern, Scheunendächern, sehr oft auf Rauchfängen, Türmen, seltener auf Bäumen und nur ausnahmsweise auf dem Boden. Der Unterbau besteht in der Regel aus starken Ästen, welcher dann mit dünnerem Reisig, Grasbüscheln, Erde, usw. zu einer flachen Mulde ausgestaltet und schliesslich mit weicheren Pflanzenteilen und -resten, Federn, Papier und anderen Abfällen ausgepolstert wird. Das Baumaterial beschaffen sich die Störche am liebsten in der nächsten Umgebung und schrecken dabei selbst vor Diebstählen aus benachbarten Nestern nicht zurück. Auch sind sie bei der Suche nicht sehr wählerisch, da wir in den Nestern neben alten Schuhen, Schuhsohlen und Kleiderresten Metallgegenstände und auch noch vieles andere finden können. Alle diese Erwerbisse und hauptsächlich die eingetragene reichliche Erde werden von den Störchen öfters mit eigens eingebrachtem Wasser begossen und dann festgestampft, so dass die Oberfläche des Nestes schliesslich zu einer steinharten, glatten, idealen Startfläche für die Jungstörche umgestaltet wird. In diesem Zustand bleibt dann das Nest nach dem Abzug der Störche (in Ungarn im Mittel um den 1. September) den ganzen Winter über. Treffen im Frühjahr die Störche wieder ein (im Mittel um den 2. April), so werden etwaige Schäden des Nestes ausgebessert und seine harte Oberfläche wird unter Neueintragen von Reisig, Gras und Erde wieder ausgepolstert. So wachsen die im ersten Jahre an die 80 cm im Durchmesser und 30—40 cm an Höhe betragenden Nester bei wiederholter Benützung im Laufe der Jahre mitunter zu wahren Riesennestern (Durchmesser bis zu 170 cm, Höhe bis zu 200 cm) heran, die ein Gewicht von nahezu 20 Zentnern erreichen können (Niethammer 1938).

Die 7 von mir untersuchten Nester (im weiteren mit den Buchstaben *A* bis *G* bezeichnet) standen alle frei auf Gebäuden in Höhen von 6—12 m, bzw. die Nester *A*, *C* und *D* auf Rauchfängen, *E*, *F* und *G* auf mit Stroh gedeckten Scheunendächern und *B* auf dem Dach eines Stalles. Die Nester *A*—*E* waren im selben Jahr benützte Nester, während Nest *F* und *G* im Untersuchungsjahre wohl ausgebessert, aber dann wieder verlassen worden waren. (Nest *G* diente vorübergehend einem alten Junggesellen als Schlafnest.) Nest *A* war das älteste (angeblich mehr als 15 Jahre alt) und auch grösste Nest (Durchmesser 1.7 m, Höhe 0.8 m, wahrscheinliches Gewicht 3—4 Zentner), weshalb es zu den jahreszyklischen Untersuchungen herangezogen wurde.

Die Untersuchungen erfolgten bei Nest *A* (Kopács) am 21. VI., 20. VIII., 21. X., 16. XI. 1943 und 31. I. 1944, bei Nest *B* (Várdaróc) am 21. X. 1943 und 31. I. 1944, bei Nest *C* (Kopács) am 15. XI. 1943, bei Nest *D* (Bellye) am 31. I. 1944, bei Nest *E* (Kopács) am 26. VI. 1944, bei Nest *F* (Kopács) am 26. VI. 1944 und schliesslich bei Nest *G* (Bátorliget) am 24. VI. 1948. [Die Gemeinden Bellye, Kopács und Várdaróc liegen im Drauwinkel (Komitat Baranya), Bátorliget im sogen. Nyírség (Komitat Szatmár)].

In allen untersuchten Nestern wurden mit einem Beil 20—40 kg Nestmaterial herausgehauen, wobei wir darauf achteten, dass Material aus möglichst allen Nestschichten erfasst werden konnte. Waren Nestlinge vorhanden, so wurden sie vorsichtig auf die eine Seite des Nestes gesetzt und nach der Materialentnahme, sowie der darauffolgenden Glättung der Nestoberfläche wieder an ihre alten Plätze zurückgebracht. Die Proben wurden an Ort und Stelle ausgesiebt (Sieb mit grosser Maschenweite) und das Gesiebe daheim in einen Ausleseapparat (System MoczarSKI-Winkler) gebracht. Am Einsammeln des Materiales waren mir in den meisten Fällen meine Kollegen Herr Dr. Z. K a s z a b und Herr Dr. N. H o m o n n a y behilflich, wofür ihnen auch an dieser Stelle gedankt werden soll.

#### *Systematische Zusammenstellung der in den Storchnestern gefundenen Coleopteren-Arten*

In der folgenden Zusammenstellung, welche die Coleopteren-Arten in systematischer Reihenfolge (nach A. Winkler, Catal. Coleopt. reg. palaearct. Wien 1925) gibt, folgen auf den Namen der Art die Fangdaten (Tag und Monat), wobei der dem Datum vorangestellte, kursiv gedruckte Buchstabe das Nest bezeichnet und die nach dem Monat (römische Ziffer) in Klammer gesetzte arabische Ziffer die Zahl der gefangenen Imagines angibt (Larven sind durch ein der Ziffer nachgesetztes La bezeichnet). In eckiger Klammer werden endlich die Namen der Vögel angegeben, aus deren Nestern die betreffende Coleopteren-Art schon bekannt war. (Die Vogelnamen sind nicht systematisch gruppiert, sondern nach der Art der Anlage ihrer Nester; zuerst werden die Arten mit Bodennestern angeführt, dann die mit frei über dem Boden angelegten Nestern und schliesslich die Arten mit Höhlen-, bzw. Halbhöhlennestern.)

- Carabus violaceus* var. *Betuliae* Csiki — G: 24. VI. (1) — (Nahrungsrest).  
*Carabus cancellatus* var. *tibiscinus* Csiki — G: 24. VI. (1) — (Nahrungsrest).  
*Calosoma sycophanta* L. — A: 21. X. (1) — (Nahrungsrest).  
*Chlaenius spoliatus* Rossi — A: 21. X. (1) — (Nahrungsrest).  
*Stenolophus mixtus* var. *Ziegleri* Panz. — A: 21. X. (1).  
*Acupalpus elegans* Dej. — A: 21. X. (2); 16. XI. (1).  
*Dytiscus* sp. — A: 21. X. (1) — (Nahrungsrest).

- Ochthebius impressus* Mrsh. — A: 31. I. (1).  
*Limnebius picinus* Mrsh. — A: 21. X. (1).  
*Cercyon unipunctatus* L. — E: 26. VI. (1); F: 26. VI. (3) — [*Ciconia ciconia*].  
*Cercyon nigriceps* Mrsh. — E: 26. VI. (2).  
*Hydrous piceus* L. — A: 20. VIII. (1); 21. X. (2); 31. I. (2); G: 24. VI. (2) — (Nahrungsreste).  
*Nemadus colonoides* Kraatz — C: 15. XI. (12); D: 31. I. (1) — [Strigidae, *Corvus cornix*, *Passer domesticus*, *Sturnus vulgaris*, *Dryobates major*, *Upupa epops*].  
*Clambus pubescens* Redtb. — A: 20. VIII. (5); 21. X. (4); 16. XI. (3); B: 21. X. (7); 31. I. (2); C: 15. XI. (1).  
*Scydmaenus rufus* Müll. — A: 20. VIII. (57); 21. X. (77); 16. XI. (45); 31. I. (1); B: 21. X. (64); 31. I. (29); D: 31. I. (1); G: 24. VI. (2).  
*Arthrolips piceus* Com. — F: 26. VI. (1).  
*Ptenidium pusillum* Gyll. — B: 21. X. (2); E: 26. VI. (1); G: 24. VI. (1).  
*Acrotrichis grandicollis* Mannh. — F: 26. VI. (3) — [*Bubo bubo*, *Falco peregrinus*, *Haliaeetus albicilla*, *Accipiter nisus*, *Falco tinnunculus*].  
*Acrotrichis intermedia* Gillm. — F: 26. VI. (1).  
*Acrotrichis brevipennis* Er. — A: 21. X. (1); E: 26. VI. (2); F: 26. VI. (1) — [*Corvus cornix*].  
*Acrotrichis sericans* Heer — F: 26. VI. (1).  
*Phyllodrepa floralis* Payk. — B: 21. X. (1) — [*Colaeus monedula*, *Sturnus vulgaris*, *Columba domestica*, *C. oenas*].  
*Trogophloeus obesus* Kiesw. — A: 31. I. (1).  
*Trogophloeus corticinus* Grav. — A: 21. VI. (12); 20. VIII. (1); 21. X. (2); 31. I. (2) — [*Corvus cornix*].  
*Trogophloeus pusillus* Grav. — A: 21. VI. (24).  
*Oxytelus fulvipes* Er. — G: 24. VI. (1).  
*Oxytelus nitidulus* Grav. — G: 24. VI. (1).  
*Oxytelus complanatus* Er. — E: 26. VI. (2).  
*Oxytelus tetracaratus* Block. — E: 26. VI. (3); F: 26. VI. (25) — [*Ciconia ciconia*].  
*Edaphus Blühweissi* Scheerp. — B: 21. X. (10).  
*Stiliculus Erichsoni* Fauv. — G: 24. VI. (1).  
*Leptacinus batychnus* Gyll. — A: 20. VIII. (1); D: 31. I. (1); F: 26. VI. (1); G: 24. VI. (1).  
*Xantholinus glaber* Nordm. — A: 21. VI. (1 La); 20. VIII. (3); 21. X. (1); 16. XI. (1); B: 21. X. (1); C: 15. XI. (10) — [*Upupa epops*, *Vogelnester*].  
*Philonthus atratus* Grav. — G: 24. VI. (1).  
*Philonthus concinnus* Grav. — A: 21. X. (1).  
*Philonthus lepidus* var. *gilvipes* Er. — E: 26. VI. (1).  
*Philonthus sordidus* Grav. — E: 26. VI. (1); F: 26. VI. (2); G: 24. VI. (8) — [*Columba domestica*, *C. oenas*].  
*Philonthus fuscus* Grav. — A: 20. VIII. (8); 16. XI. (1); 31. I. (4); B: 21. X. (1); F: 26. VI. (1) — [*Ciconia ciconia*, *Bubo bubo*, *Corvus cornix*, *Fringilla coelebs*, *Haliaeetus albicilla*, *Accipiter nisus*, *Mergus merganser*, *Colaeus monedula*, *Sturnus vulgaris*, *Dryobates major*, *Falco tinnunculus*, *Columba domestica*, *C. oenas*].  
*Philonthus appendiculatus* Shp. — A: 31. I. (1).  
*Falagria splendens* Kraatz — F: 26. VI. (1).  
*Atheta inquinula* Grav. — F: 26. VI. (2) — [*Upupa epops*].

*Atheta parvula* Mannh. — F: 26. VI. (1); G: 24. VI. (7).

*Atheta* sp. — E: 26. VI. (2).

*Oxypoda opaca* Grav. — F: 26. VI. (1) — [*Ardea cinerea*, *Muscicapa hypoleuca*].

*Oxypoda nigrocincta* Muls. — B: 21. X. (1).

*Microglotta marginalis* Grav. — A: 16. XI. (2); B: 21. X. (1) — [*Strigidae*, *Accipiter gentilis*, *Paridae*, *Sturnus vulgaris*, *Dryocopus martius*, *Upupa epops*, *Columba domestica*].

*Aleochara bipustulata* L. — F: 26. VI. (1).

*Staphylinidae* (Larven) — E: 26. VI. (1); F: 26. VI. (54); G: 24. VI. (11).

*Euplectus sanguineus* Denny — A: 20. VIII. (1).

*Euplectus signatus* Reichb. — A: 20. VIII. (3); 21. X. (3); B: 21. X. (43); 31. I. (9).

*Euplectus Karsteni* var. *falsus* Bedel — A: 21. VI. (5); 20. VIII. (590); 21. X. (263); 16. XI. (84); 31. I. (6); B: 21. X. (6); C: 21. X. (39); D: 31. I. (27); G: 24. VI. (28) — [*Strigidae*, *Turdus philomelos*, *Motacilla alba*, *Muscicapa hypoleuca*, *Hirundo rustica*, *Delichon urbica*, *Apus apus*, *Colaeus monedula*, *Dryocopus martius*, *Dryobates major*, *Falco tinnunculus*].

*Bibloporus bicolor* Denny — G: 24. VI. (1).

*Biblopectus minutissimus* Aubé — B: 31. I. (1).

*Acritus nigricornis* Hoffm. — A: 20. VIII. (3); B: 21. X. (2); 31. I. (1); C: 15. XI. (2); G: 24. VI. (2).

*Gnathoncus punctulatus* Thoms. — A: 20. VIII. (31); 21. X. (47); 16. XI. (148); 31. I. (108); B: 21. X. (24); 31. I. (59); C: 15. XI. (8); D: 31. I. (13) — [*Ciconia ciconia*, *Ardea cinerea*, *Strigidae*, *Corvidae*, *Pica pica*, *Buteo buteo*, *Parus major*, *Muscicapa hypoleuca*, *Colaeus monedula*, *Sturnus vulgaris*, *Dryobates major*, *Upupa epops*, *Columba domestica*, *C. oenas*, *Hühnerställe*].

*Dendrophilus punctatus* Hbst. — A: 21. VI. (1); 20. VIII. (6); 21. X. (26); 16. XI. (31); 31. I. (10); D: 31. I. (2) — [*Ciconia ciconia*, *Strigidae*, *Corvus cornix*, *Fringilla coelebs*, *Regulus regulus*, *Accipiter nisus*, *Parus major*, *P. ater*, *P. atricapillus*, *Muscicapa striata*, *M. hypoleuca*, *Phoenicurus phoenicurus*, *Hirundo rustica*, *Delichon urbica*, *Apus apus*, *Mergus merganser*, *Colaeus monedula*, *Sturnus vulgaris*, *Dryocopus martius*, *Dryobates major*, *Upupa epops*, *Falco tinnunculus*, *Columba oenas*].

*Carcinops 14-striata* Steph. — A: 21. VI. (13); 20. VIII. (105); 21. X. (116); 16. XI. (83); 31. I. (27); B: 21. X. (10); 31. I. (5); C: 15. XI. (2); F: 26. VI. (1); G: 24. VI. (1) — [*Ciconia ciconia*, *Ardea cinerea*, *Strigidae*].

*Hister corvinus* Germ. — G: 24. VI. (2) — [*Columba domestica*].

*Opetiopalpus scutellaris* Panz. — G: 24. VI. (5).

*Elatér Megerlei* Lac. — A: 31. I. (1).

*Heterocerus fuscus* Kiesw. — A: 31. I. (1).

*Dermestes bicolor* F. — A: 21. VI. (12 La); 20. VIII. (6 La); 21. X. (10); 16. XI. (3); 31. I. (77); B: 20. VIII. (2); C: 15. XI. (1); E: 26. VI. (1); G: 24. VI. (1) — [*Passer hispaniolensis*, *Hühnerställe*, *Taubenschläge*, *Vogelnester*].

*Dermestes lardarius* L. — A: 21. VI. (192 La); 20. VIII. (24 La); E: 26. VI. (73 La); F: 26. VI. (19 La) — [*Ardea cinerea*, *Passer domesticus*, *Motacilla alba*, *Hirundo rustica*, *Delichon urbica*, *Apus apus*, *Colaeus monedula*, *Columba domestica*].

*Attagenus piceus* Oliv. — A: 21. X. (6 La); 16. XI. (3 La); 31. I. (50 La); B: 31. I. (1); G: 24. VI. (1 La) — [*Passer hispaniolensis*, *Hirundo domestica*, *Delichon urbica*, *Columba domestica*].

- Anthrenus pimpinellae* Fabr. — A: 21. X. (116+10 La); 16. XI. (7); 31. I. (61); B: 21. X. (16+1 La); 31. I. (8+3 La); C: 15. XI. (1+1 La); D: 31. I. (2) — [Passer domesticus, Motacilla alba, Delichon urbica, Columba domestica].
- Anthrenus goliath* Muls. — A: 21. X. (39); 16. XI. (9+1 La); 31. I. (95+? 74 La); B: 31. I. (1); D: 31. I. (1) — [Passer hispaniolensis].
- Anthrenus scrophulariae* L. — B: 21. X. (3); 31. I. (1) — [Hirundo rustica].
- Syncalypta spinosa* Rossi — A: 21. VI. (1).
- Tenebrioides mauritanicus* L. — A: 21. X. (1 La); 31. I. (17 La) — [Colaeus monedula, Columba domestica].
- Monotoma bicolor* Villa — A: 20. VIII. (7); 21. X. (23); 16. XI. (22); 31. I. (5); B: 21. X. (2); D: 31. I. (1); E: 26. VI. (1); F: 26. VI. (7); G: 24. VI. (7).
- Cryptophagus hirtulus* Kr. — A: 31. I. (1).
- Cryptophagus badius* Strm. — G: 24. VI. (2) — [Columba domestica].
- Atomaria ruficornis* Mrsh. — F: 26. VI. (1) — [Delichon urbica, Vogelnester].
- Holoparamesus caularum* Aubé — B: 21. X. (2).
- Enicmus minutus* L. — B: 21. X. (2); 31. I. (1) — [Ciconia ciconia, Pyrrhula pyrrhula, Fringilla coelebs, Turdus philomelos, T. musicus, T. merula, Passer domesticus, Motacilla alba, Certhia familiaris, Parus ater, Muscicapa hypoleuca, Phoenicurus phoenicurus, Hirundo rustica, Delichon urbica, Colaeus monedula, Sturnus vulgaris, Columba oenas].
- Cartodere elegans* Aubé — A: 31. I. (1); B: 21. X. (2) — [Delichon urbica].
- Cartodere filiformis* Gyll. — A: 20. VIII. (12); 21. X. (19); 16. XI. (19); 31. I. (1); B: 21. X. (2); G: 24. VI. (3) — [Pica pica, Pyrrhula, pyrrhula, Turdus pilaris, T. philomelos, T. musicus, T. merula, Passer domesticus, Motacilla alba, Muscicapa hypoleuca, Phoenicurus phoenicurus, Hirundo rustica, Delichon urbica, Colaeus monedula, Columba domestica].
- Corticaria serrata* Payk. — A: 20. VIII. (17); 21. X. (8); 16. XI. (15); 31. I. (6); B: 21. X. (2); C: 15. XI. (4); G: 24. VI. (4) — [Corvus cornix, Regulus regulus, Turdus philomelos, T. musicus, Passer domesticus, Motacilla alba, Certhia familiaris, Parus major, P. ater, Muscicapa hypoleuca, Phoenicurus phoenicurus, Hirundo rustica, Delichon urbica, Colaeus monedula].
- Corticarina fuscata* Gyll. — A: 31. I. (1).
- Typhaea stercorea* L. — F: 26. VI. (1) — [Ciconia ciconia].
- Aglenus brunneus* Gyll. — A: 21. X. (1); 16. XI. (1); 31. I. (17).
- Cerylon histeroides* F. — G: 24. VI. (15).
- Ptinus fur* L. — A: 21. X. (1); 16. XI. (1); 31. I. (2); B: 21. X. (2) — [Fringilla coelebs, Motacilla alba, Parus major, Hirundo rustica, Delichon urbica, Colaeus monedula, Columba domestica].
- Aderus populneus* Panz. — B: 21. X. (3).
- Anthicus floralis* L. — F: 26. VI. (6).
- Tenebrio molitor* L. — A: 21. VI. (3 La); 20. VIII. (24 La); 21. X. (1+106 La); 16. XI. (60 La); 31. I. (358 La); B: 21. X. (24 La); 31. I. (12 La); C: 15. XI. (1+1 La); D: 31. I. (17+12 La); G: 24. VI. (2 La) — [Passer domesticus, Hirundo rustica, Delichon urbica, Colaeus monedula, Hühnerställe].
- Copris lunaris* L. — G: 24. VI. (2) — (Nahrungsreste).
- Aphodius granarius* L. — A: 20. VIII. (4); 16. XI. (1).
- Diasticus tibialis* F. — A: 21. VI. (2); 20. VIII. (2); 21. X. (4); 16. XI. (3); E: 26. VI. (1).

- Pleurophorus caesus* Creutz. — B: 31. I. (2); D: 31. I. (2); G: 24. VI. (1).  
*Trox scaber* L. — A: 21. VI. (8); 20. VIII. (154+4 La); 21. X. (180); 16. XI. (265); 31. I. (256); B: 21. X. (79), 31. I. (117); C: 15. XI. (131); D: 31. I. (134); G: 24. VI. (23+3 La) — [*Ciconia ciconia*, *Bubo bubo*, *Falco tinnunculus*, *F. peregrinus*, *Haliaeetus albicilla*, *Parus* sp. *Colaeus monedula*, *Dryobates major*, *Upupa epops*].  
*Melolontha melolontha* L. — G: 24. VI. (1) — (Nahrungsrest).  
*Potosia cuprea* F. — B: 21. X. (1 La); G: 24. VI. (3+28 La).  
*Galerucella luteola* Müll. — B: 21. X. (2).  
*Chalcoides Plutus* Latr. — D: 31. I. (2).  
*Epithrix pubescens* Koch — A: 20. VIII. (1).  
*Bruchus pisorum* L. — D: 31. I. (1).  
*Gymnetron rostellum* var. *stimulosum* Germ. — G: 24. VI. (1).  
 Verschiedene Käferlarven: A: 31. I. (7); B: 31. I. (3); D: 31. I. (1); F: 26. VI. (22).

In den untersuchten Storchnestern wurden also insgesamt 89 Coleopteren-Arten nachgewiesen, zu welchen noch weitere 8 Arten hinzukommen, die allerdings nur als Überreste der Storchnahrung gefunden wurden. Von den 89 Arten waren bisher 9 (*Cercyon unipunctatus*, *Oxytelus tetracaratus*, *Philonthus fuscus*, *Gnathonus punctulatus*, *Dendrophilus punctatus*, *Carcinops 14-striata*, *Enicmus minutus* und *Typhoea stercorea*, sowie *Trox scaber*) schon aus Storchnestern bekannt, sowie 34 im allgemeinen aus verschiedenen Vogelnestern. Von den aus Storchnestern bisher bekannt gegebenen Arten (s. Bickhardt und Weber) konnten 6 Arten nicht wiedergefunden werden.

Vor allem mögen nun hier einige Arten Erwähnung finden, welche in den untersuchten Storchnestern in grösseren Individuenzahlen gefangen wurden: *Scydmaenus rufus* — 276 Ex., *Euplectus Karsteni* var. *falsus* — 1048 Ex., *Gnathonus punctulatus* — 438 Ex., *Dendrophilus punctatus* — 76 Ex., *Carcinops 14-striata* — 363 Ex., *Dermestes bicolor* — 95 Ex., *Dermestes lardarius* — 308 Larven, *Attagenus piceus* — 61 Larven, *Anthrenus pimpinellae* — 211 Ex., *Anthrenus goliath* — 145 Ex., *Tenebrio molitor* — 602 Larven und schliesslich *Trox scaber* — 1347 Ex.

Die Funde von *Edaphus Blühweissi* Scheerp. und *Cartodere elegans* Aubé stellten den ersten Nachweis dieser Arten in der Fauna Ungarns dar. Über *Anthrenus goliath* Muls., der aus Ungarn bis zu den Massenfunden in den Storchnestern nur in einem einzigen Exemplar aus Kalocsa (Coll. Speiser) bekannt war, hatte ich schon im Jahre 1944 mitgeteilt, dass er neben *A. pimpinellae* als eigene, gute Art aufzufassen sei. Dieselbe Ansicht äusserte nun in ebendemselben Jahre (1944) auch Korschefsky, welcher aus dem Nest eines Weidensperlings (*Passer hispaniolensis*) aus Mazedonien Larven von *Tenebrio molitor* und *Attagenus piceus*, sowie Imagines von *Dermestes bicolor* und *Anthrenus goliath* nachwies. Die von Korschefsky geäusserte Annahme, dass die vier von ihm besprochenen Arten vielleicht aus dem Storchnest „übergelaufen“ wären, an dessen Unterbau das Sperlingsnest angebracht erschien, ist nicht von der Hand zu weisen, da alle vier Arten in Storchnestern in grosser Anzahl vorzukommen scheinen.

#### Ökologische Bemerkungen

Die bisher vorliegenden Ergebnisse berechtigen vielleicht noch nicht in vollem Ausmasse, entgültige Schlüsse über die ökologischen Verhältnisse in Storchnestern zu



ziehen. Doch dürften sie hinreichend sein, einige wertvoller scheinende Feststellungen zu machen, auf jeden Fall aber hinreichend, die Richtung weiterer Untersuchungen festzulegen. Abgesehen davon, dass die Zahl der untersuchten Nester wohl noch zu gering ist, scheint auch die Untersuchungsmethode mangelhaft. Das ganze Nestmaterial, bzw. ein bestimmtes Volumen desselben in Gänze in einen Ausleseapparat zu bringen, wie es Nordberg tat, ist beim Storchnest unmöglich, bzw. infolge seiner Grösse und auch seines heterogenen Aufbaues. Deshalb ist vor allem Sieben nicht zu vermeiden. Die Unmöglichkeit, gleiche Volumina Nestmaterialies miteinander zu vergleichen, suchte ich dadurch auszumerzen, dass ich möglichst grosse Mengen Nestmaterialies untersuchte, wodurch die quantitativen Werte näher an die Wahrscheinlichkeitsgrenze heranrücken.

Eines der Ziele der Untersuchungen war der Versuch, die cönologischen Gruppen (sensu Kroggerus) der Nidicolen des Storchnestes schärfer umreissen, bzw. womöglichst unter Zugrundelegung fixer Vergleichszahlen. Zu diesem Zweck untersuchte ich neben der Konstanz der Arten in allen Nestern auch die Konstanz der Arten in einunddemselben Nest zu verschiedenen Zeitpunkten. Ebenso stellte ich neben der Dominanz der Arten in allen Nestern auch die der Arten in einem Nest zu verschiedenen Zeitpunkten fest. Für diese jahreszyklischen Untersuchungen, also für die Klarlegung der Verhältnisse in einem einzigen Storchnest während eines ganzen Jahres, erwies sich Nest A aus Kopács infolge seiner Grösse als sehr geeignet. Nach fünfmaliger Untersuchung (im Juni, August, Oktober, November und Jänner) stürzte das Nest aber ab, so dass eine weitere für März geplante Untersuchung leider unmöglich wurde.

#### *Konstanz der Arten in den 7 untersuchten Storchnestern*

Es wurden nachgewiesen

in 7 Nestern: —

in 6 Nestern: *Monotoma bicolor*.

in 5 Nestern: *Euplectus Karsteni* var. *falsus*, *Carcinops 14-striata*, *Dermestes bicolor*, *Tenebrio molitor*, *Trox scaber*.

in 4 Nestern: *Scydmaenus rufus*, *Leptacinus batychnus*, *Acritus nigricornis*, *Gnathoncus punctulatus*, *Anthrenus pimpinellae*, *Corticaria serrata*.

in 3 Nestern: *Clambus pubescens*, *Ptenidium pusillum*, *Acrotrichis brevipennis*, *Xantholinus glaber*, *Philonthus sordidus*, *Philonthus fuscus*, *Dermestes lardarius*, *Attagenus piceus*, *Anthrenus goliath*, *Cartodere filiformis*, *Pleurophorus caesus*.

#### *Konstanz der Arten in einunddemselben Nest zu verschiedenen Zeitpunkten*

Anlässlich der fünfmaligen Untersuchung des Nestes A wurden gefangen

fünfmal: *Euplectus Karsteni* var. *falsus*, *Dendrophilus punctatus*, *Carcinops 14-striata*, *Dermestes bicolor*, *Tenebrio molitor*, *Trox scaber*.

viermal: *Scydmaenus rufus*, *Trogophloeus corticinus*, *Xantholinus glaber*, *Gnathoncus punctulatus*, *Monotoma bicolor*, *Cartodere filiformis*, *Corticaria serrata*, *Diastrictus tibialis*.

dreimal: *Clambus pubescens*, *Philonthus fuscus*, *Attagenus piceus*, *Anthrenus pimpinellae*, *Anthrenus goliath*.

Addieren wir nun die Zahl der untersuchten Nester (7) und die Zahl der wiederholten Untersuchungen an Nest A (5), dann erhalten wir die Zahl 12, die ich als die

Kennzahl des Storchnestes bezeichne. Stellen wir weiters für die einzelnen in diesem Zusammenhang besprochenen Arten ebenfalls die Kennzahl fest (Anzahl der Nester, in welchen die Art nachgewiesen wurde, plus Zahl, welche angibt, wie oft die Art in Nest A angetroffen wurde) so kommen wir zu folgender Gruppierung der Coleopteren-Arten.

Gruppe I. Arten, deren Kennzahl grösser ist als 50 % der Kennzahl des Nestes, im vorliegenden Falle also grösser als 6: *Scydmaenus rufus*, *Xantholinus glaber*, *Euplectus Karsteni* var. *falsus*, *Gnathoncus punctulatus*, *Carcinops 14-striata*, *Dermestes bicolor*, *Attagenus piceus*, *Anthrenus pimpinellae*, *Monotoma bicolor*, *Cartodere filiformis*, *Corticaria serrata*, *Tenebrio molitor*, *Trox scaber*.

Gruppe II. Arten, deren Kennzahl gleich 50 % der Kennzahl des Nestes, d. i. in unserem Falle 6, ist oder kleiner: *Clambus pubescens*, *Ptenidium pusillum*, *Acrotrichis brevipennis*, *Trogophloeus corticinus*, *Leptacinus batychnus*, *Philonthus sordidus*, *Philonthus fuscus*, *Acritus nigricornis*, *Dendrophilus punctatus*, *Dermestes lardarius*, *Anthrenus goliath*, *Diastictus tibialis*, *Pleurophorus caesus*.

Gruppe III. Arten, die in diesen beiden Konstanz-Zusammenstellungen nicht vorkommen, die also höchstens in zwei der untersuchten Nester gefangen wurden, bezw. in Nest A höchstens zweimal. Dieser Gruppe gehören also die restlichen 63 Coleopteren-Arten der Storchnester an.

Die hier eingeführte Kennzahl enthält also neben dem bekannten Konstanzbegriff noch einen weiteren, neuen Faktor, einen Zeitbegriff, welcher darauf hinweist, ob die betreffende Art in dem untersuchten Nest sich nur vorübergehend aufhält, oder ob sie aber in ihrer Lebensweise, bezw. Entwicklung an das Nest gebunden ist, mit anderen Worten, ob sie im Nest alle für ihr Fortkommen notwendigen Prämissen vorfindet oder nicht. Diese Kennzahl kann deshalb als mathematischer Ausdruck der cönologischen Gruppen betrachtet werden. So fasse ich alle Arten, deren Kennzahl grösser ist als 50 % der Kennzahl des Nestes als eucöne Arten auf (Gruppe I), Arten, deren Kennzahl gleich 50 % oder kleiner ist, als tychocone (Gruppe II) und schliesslich alle Arten die in keiner der beiden obenstehenden Konstanz-Zusammenstellungen vorkommen als xenocön (Gruppe III).

Dass nun diese willkürlich erscheinende Trennung (die Grenze zwischen tychoconen und xenocönen Arten liess sich einstweilen noch nicht absolut scharf festlegen) jedoch den tatsächlichen Verhältnissen entsprechen dürfte, zeigt die folgende Zusammenstellung.

#### *Konstanz der Arten in im gleichen Zeitpunkt untersuchten Nestern*

In den 4 in den Monaten Juni und August untersuchten Nestern (A, E, F, G) wurden nachgewiesen

in 4 Nestern: *Monotoma bicolor*.

in 3 Nestern: *Leptacinus batychnus*, *Philonthus sordidus*, *Carcinops 14-striata*, *Dermestes bicolor*.

in 2 Nestern: *Cercyon unipunctatus*, *Ptenidium pusillum*, *Acrotrichis brevipennis*, *Oxytelus tetracaratus*, *Atheta parvula*, *Euplectus Karsteni* var. *falsus*, *Cartodere filiformis*, *Corticaria serrata*, *Tenebrio molitor*, *Diastictus tibialis*, *Trox scaber*.

Den 2 im Oktober untersuchten Nestern (A, B) waren gemeinsam

in 2 Nestern: *Clambus pubescens*, *Scydmaenus rufus*, *Xantholinus glaber*, *Euplectus signatus*, *Gnathonus punctulatus*, *Carcinops 14-striata*, *Dermestes bicolor*, *Anthrenus pimpinellae*, *Monotoma bicolor*, *Cartodere filiformis*, *Corticaria serrata*, *Ptinus fur*, *Tenebrio molitor*, *Trox scaber*.

Den 2 im November untersuchten Nestern (A, C) waren gemeinsam

in 2 Nestern: *Clambus pubescens*, *Xantholinus glaber*, *Euplectus Karsteni* var. *falsus*, *Gnathonus punctulatus*, *Carcinops 14-striata*, *Dermestes bicolor*, *Anthrenus pimpinellae*, *Corticaria serrata*, *Tenebrio molitor*, *Trox scaber*.

Den 3 im Jänner untersuchten Nestern (A, B, D) waren gemeinsam

in 3 Nestern: *Scydmaenus rufus*, *Euplectus Karsteni* var. *falsus*, *Gnathonus punctulatus*, *Anthrenus pimpinellae*, *Anthrenus goliath*, *Tenebrio molitor*, *Trox scaber*.

in 2 Nestern: *Dendrophilus punctatus*, *Carcinops 14-striata*, *Attagenus piceus*, *Monotoma bicolor*, *Pleurophorus caesus*.

In dieser Zusammenstellung treten also neben eucönen und tychoönen Arten nur 5 xenocöne Arten auf, usw. *Cercyon unipunctatus*, *Oxytelus tetracarinatus*, *Atheta parvula*, *Euplectus signatus* und *Ptinus fur*, so dass auch diese Zusammenstellung die oben besprochenen Verhältnisse zu decken scheint.

Inwieweit nun diese mathematische Fixierung der cönologischen Gruppen auch für andere Tierbestände zutrifft, oder ob sie nur für die Nidicolen zurechtbesteht, müssen weitere Untersuchungen entscheiden.

In den 7 Storchnestern wurden gelegentlich der durchgeführten 12 Aufsammlungen insgesamt 5885 Coleopteren, bzw. Coleopteren-Larven gefangen. Berechnen wir nun die in den Storchnestern herrschenden Dominanzverhältnisse<sup>1</sup>, so erhalten wir im Durchschnitt der 12 Aufsammlungen folgende Werte:

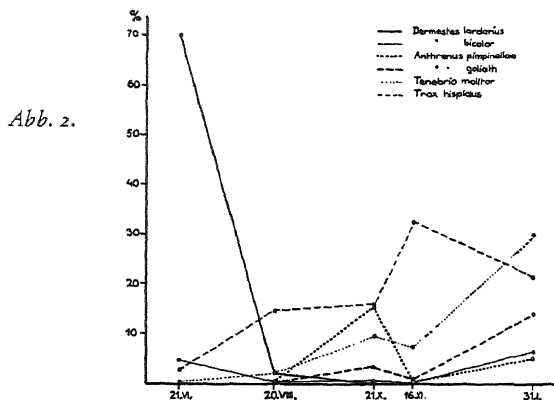
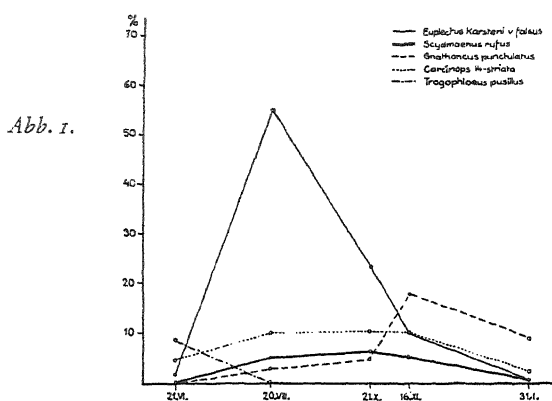
Dominante Arten:		Influente Arten:	
<i>Trox scaber</i> .....	23.1 %	<i>Scydmaenus rufus</i> .....	4.6 %
<i>Euplectus K.</i> var. <i>falsus</i> .....	17.8 %	<i>Anthrenus pimpinellae</i> .....	3.8 %
<i>Tenebrio molitor</i> .....	10.5 %	<i>Anthrenus goliath</i> .....	3.5 %
<i>Gnathonus punctulatus</i> .....	7.5 %		
<i>Carcinops 14-striata</i> .....	6.1 %		
<i>Dermestes lardarius</i> .....	5.2 %		

Von diesen 9 Arten sind 7 eucön, 2 (*Dermestes lardarius* und *Anthrenus goliath*) nach den obigen Ausführungen tychoön.

Die Berechnung der Dominanzverhältnisse ist Nest A während der Monate Juni bis Jänner ergibt ein schönes Bild ihrer jahreszyklischen Veränderungen. Abb. 1 zeigt den Verlauf der Dominanzkurve der Zoophagen, Abb. 2 den der Schizophagen.

Aus Abb. 1 geht hervor, dass die Dominanzwerte der Zoophagen im allgemeinen von Juni an ansteigen, im August—November kulminieren und dann gegen Jänner zu stark abfallen. Diese Ergebnisse stimmen mit den Feststellungen Nordbergs bis zu einem gewissen Grade überein, nach welchen die Raubkäfer im Herbst die Vogelnester verlassen. Die Zoophagen verschwinden jedoch aus dem Storchnest auch im Winter nicht vollständig, doch sinkt ihre Verhältniszahl ziemlich beträchtlich ab.

<sup>1</sup> Ich hatte auch in dieser Arbeit an der alten Individuendominanz fest und verweise bezüglich des Grundes dieses Vorgehens auf die diesbezüglichen Ausführungen meiner Publikation aus dem Jahre 1944.



(anstelle *Trox hispidus* lies *Trox scaber*)

Die Schizophagen lassen aber nach Abb. 2 ein ganz abweichendes Verhalten erkennen. Nach einem allmählichen Anstieg der Dominanzwerte von Juni an und einem meist im November eintretenden, vorübergehenden Absinken derselben steigen sie fast ausschliesslich gegen Ende Jänner zu wieder beträchtlich an. Die Schizophagen verlassen also das Storchnest im Winter ebenfalls nicht, sondern zeigen im Jänner sogar einen verhältnismässig kräftigen Anstieg.

Auffallend ist das abweichende Verhalten von *Dermestes lardarius*, bezw. das seiner Larven. *Dermestes lardarius* stellt nämlich, wie Abb. 2 zeigt, im Monate Juni — die Störche füttern noch ihre Jungen — einen sehr hohen Prozentsatz der Gesamtindividuenzahl dar, welcher dann bis Ende August — die Störche haben das Nest verlassen — rasch abfällt, um schliesslich im Oktober unter 2 % abzusinken. Dieses mit der Anwesenheit der Jungstörche engstens verknüpft scheinende Verhalten veranlasste mich schon 1944, gestützt auf die Untersuchungen von Burckhardt und Kolbe, die Ansicht auszusprechen, dass die Larven von *Dermestes lardarius* gelegentlich als Parasiten an den Storchjungen auftreten können und so neben anderen Ursachen

(s. Szidat) vielleicht ebenfalls der Grund des oft rätselhaft erscheinenden Jungenmordes der Störche sein dürften. Einen weiteren Beweis für die Richtigkeit dieser Annahme sehe ich auch in dem Vergleich der beiden Dachnester *E* und *F*. Im Nest *E* (mit 2 Jungen) zeigte nämlich *Dermestes lardarius* im Juni einen Dominanzwert von 79.3 %, während dieser Wert zur selben Zeit in dem verlassenen Nest *F* nur 12.1 % betrug.

Vergleichen wir nun abschliessend die in Storchnestern gefundenen Coleopteren-Arten mit den Ergebnissen Nordbergs, so sehen wir, dass das frei über dem Erdboden angelegte Storchnest nicht in die von Nordberg und auch von Lehnert gegebene Gruppierung der Vogelnester stimmt. Die grosse Zahl der in Storchnestern vorkommenden Arten, sowie der Umstand, dass die bisher auch aus anderen Vogelnestern nachgewiesenen Coleopteren-Arten des Storchnestes vorzüglich in Höhlen- und Halbhöhlennestern leben (vergl. systematische Zusammenstellung), verweisen nämlich das Storchnest in scharfem Gegensatz zu seiner Anlageweise ganz eindeutig zu den Höhlennestern und nicht zu den im Freien über der Erde angelegten Nestern. Der Grund für dieses abweichende Verhalten ist nun in der eingangs geschilderten Bauweise des Storchnestes zu suchen, das in seiner obersten Schichte während der Brut- und Fütterungsperiode tatsächlich einem Vogelnest entspricht, in seinen tieferen, durch die festgestampfte Oberfläche weitgehendst isolierten Schichten aber Verhältnisse aufweist, welche den bodenchemischen und bodenbiologischen Verhältnissen von Kleinhöhlenbiotopen oder anderen Bodenbiotopen sehr ähnlich sein dürften.

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## THE GEOLOGICAL PRINCIPLES OF SPECIES EVOLUTION IN NEW GUINEA

(A Study on Parallelisms in geological and lepidopterological Development)

By *L. J. Toxopeus*

This study regards the butterflies of New Guinea and its surroundings.

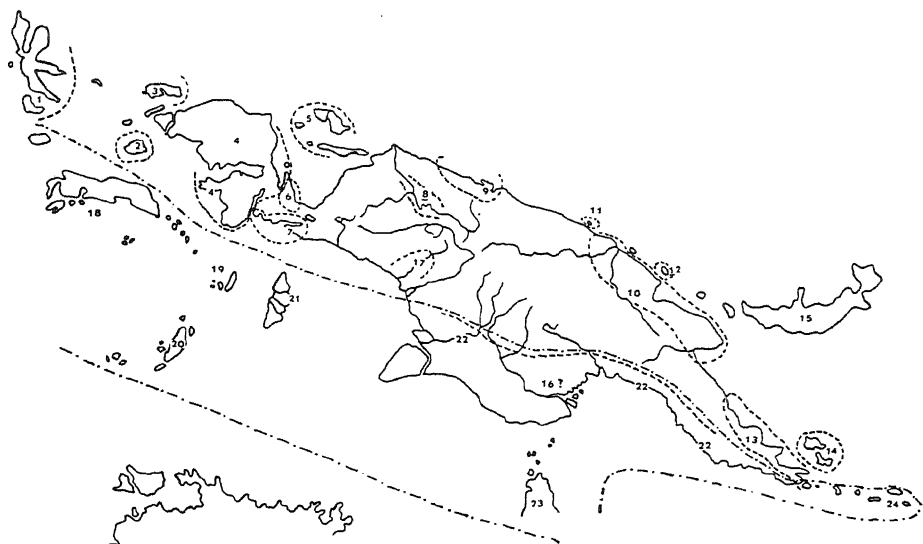
I had the good luck of being appointed to be leader of the Dutch part of a combined American-Dutch expedition which explored the central parts of northern Dutch New Guinea in the years 1938 and 1939. This expedition is known as the Third Archbold Expedition to New Guinea. The war delayed an extensive publication of the entomological results, but the collection of insects survived fairly undamaged in the Zoological Museum of Buitenzorg, Java. The Japanese occupation and subsequent post-war riots have done little harm to them, and they are now, as before, cared for in the best way under the supervision of Mr. M. A. Liefstinck, Director of that Museum and a well-known entomologist.

In the years following the expedition and in the first year of the Japanese interregnum I studied the butterflies of our entomological material, and my conclusions are mainly based on this investigation. An itinerary and a short description of collecting spots was published in *Treubia* 1941 (with a map).

During the expedition it was our goal to get a rather complete outline of the fauna and flora of the district explored, that is: the region between Humboldt Bay on the north coast, and Mt. Wilhelmina in the middle of the Snow Mountains. This area covers all formations from tropical swamps to alpine meadows above timber line, from sea level to more than 14000 feet.

Mr. Richard Archbold, our general leader, had planned to explore this in the following manner: establishing three base camps for a lasting occupation and to contain our supplies, one at Hollandia on Humboldt Bay for shipping goods on and off and as a regular base of our hydroplane; another on the River Mamberamo as an emergency base for the inland party and a starting point for the exploration of the mountainous region beyond; and finally a third base camp at Lake Habbema at 11000' above sea level, from which Mt. Wilhelmina would be easily accessible. Working camps were to be established at intervals of about 2000' of altitude, and shifted every month. This interval of 2000' of altitude in the tropics causes an almost complete change of fauna and flora. The successive stages are the same as they are in other countries of the same latitude, and only a more or less sheltered condition and the amount of sunshine may effectuate changes in the vertical distribution of species. Running water, as a rule, carries plants and animals from the mountain slopes down to lower altitudes and it is nothing out of the common to find mountain forms near the mouth of a river far below their normal collecting places. But, as a rule, species cling to their zone.

Entomological collections were made from June, 1938, to May, 1939, in fifteen successive camps. There was no trouble with the population, nor were we hampered by severe sickness, transportation difficulties or lack of materials, so collecting went on smoothly during the whole of the period. The commander of the military force, captain J. Teerink, since killed in action, and his officers, all contributed to our success by taking on the burden of building camps and clearing roads. A rough estimation of



Distribution scheme of *Papilio* (*Polydorus*) (L.). — = Boundary of red-headed subspecies group. 1. *septentrionalis* Roths., N. Moluccas; 2. *leodamas* Wall., Misool; 3. *asinius* Fruhst., Waigen; 4. *godartianus* Luc., E. side Vogelkop, Roon I., Onin Pen.; 5. *meforanus* Roths. (= *schoutensis* J. & Talb.), Mefor, Biak, Japen; 6. *wangaarensis* J. & Talb., Wangaar R., Weyland Mts.; 7. *ceramites* Fruhst., Etna Bay, Kaimana; 8. *mamberamus* n. subsp.; Mamberamo R. basin; 9. *humboldti* Roths., Humboldt Bay, Tanah Merah Bay to Sarmi (?); 10. *plagiatus* Roths. (? = *lascarus* Fruhst.), Astrolabe Bay to Huon Gulf; 11. *vulcanicus* Roths., Vulcan I.; 12. *dampierensis* Hag., Dampier I.; 13. *albosignatus* Fruhst., S. E. Papua, Milne Bay, Collingwood Bay, Kumusi R.; 14. *naissus* Fruhst., Fergusson I.; 15. *novobritanicus* Roths., New Britain; 16. *voluptitius* Fruhst., Patria ignota (probably Fly R.); 17. *auster* v. E., Lorentz R.; 18. *polydorus* L., Amboyna, Ceram, Saparua, Obi, Maniwoko I.; 19. *thessalia* Swinh., Key, Tioor; 20. *tenimberensis* Roths., Tenimber; 21. *varus* Fruhst., Aru Is.; 22. *orinomus* Roths., Eilanden R., Fly R., Yule I., Port Moresby, inland, Mekeo; 23. *queenslandicus* Roths., Cape York, Thursday I., Darnley I., Cooktown; 24. *aignanus* Roths., St. Aignan, Sudest I. — 1 to 17 are black-heads, 18 to 24 are red-heads.

the number of insects shows a figure of about one hundred thousand specimens, but this may be rather low. I had to identify nearly 500 species of butterflies, and, though this work is far from complete at this moment, it is this group that provided me with the data necessary for the present essay.

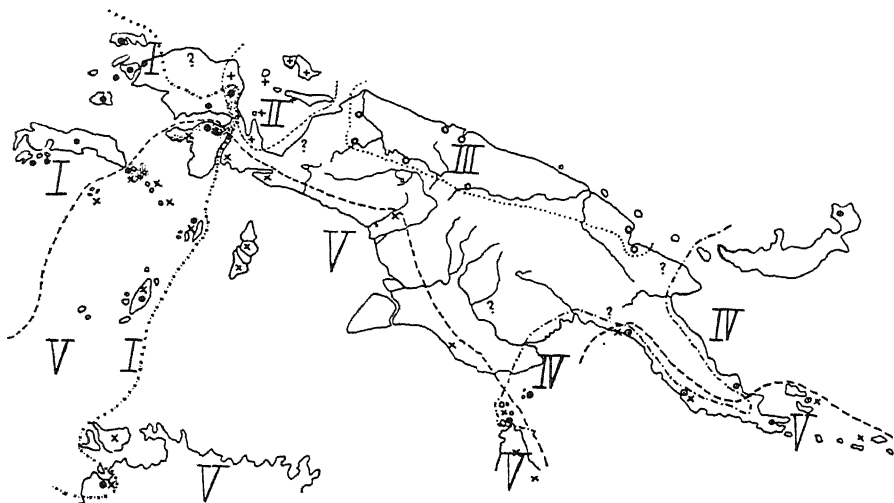
Botanical geographers of the nineteenth century (Grisebach 1872, Engler 1882, Warburg 1890) considered the flora of New Guinea to be of Asiatic origin, in contradiction to zoologists, who maintained an Australian origin of the Papuan fauna. In my opinion, we may assume a strong autonomy of its fauna; and, like Madagascar, which notwithstanding its proximity to the continent of Africa, has an old nucleus of Asiatic affinities, New Guinea possesses a great deal of Asiatic genera of butterflies, and its species are partly nearly related to those of the Malayan part of the Indian Archipelago, partly even the same as these, while others are endemics. The influence of Australia is restricted to the southern and eastern part, with very few exceptions.

Regarding endemism, New Guinea shows a strong development of endemic genera and species. Nowhere will be found such an accumulation of fantastic structures and extraordinary colours. In butterflies I have only to mention the green and golden *Troides*, the gaudy *Delias*, the mass of *Tenaris species*, the splendid *Miletus*, and the luminous blue *Thysonotis* and allied genera among the Lycaenids. *Delias* is represented by more than 80 species, whereas the other large islands contribute only 7 to 12 species, and Australia even less.

The tropical parts of Australia contain many faunal elements in common with New Guinea, which, however, are lacking in South Australia, and show no relationship to forms from that part of the Continent. This indicates that it would be better to speak of a Papuan element in the Australian fauna than to consider the New Guinea species as being derived from their congeners in Australia. To express it in other words: *this part of the Australian fauna is atypical for Australia*.

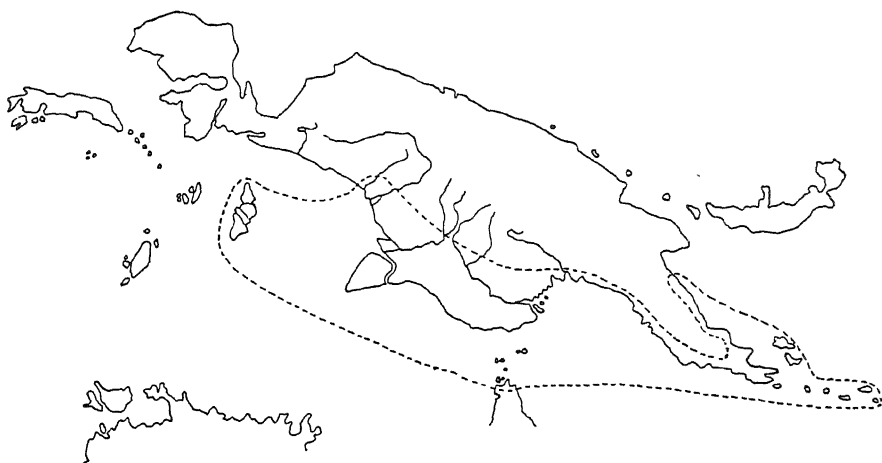
The abundance of species and subspecies of New Guinea is really stupendous, far more than proportional to the dimensions of the island. This may be attributed either to numerous immigrations, or to local development.

The former has to be rejected because the number of both Malayan and Australian species decreases in the direction of New Guinea, and the sum of the remaining units shows a figure far below the actual number of species inhabiting New Guinea. There are, indeed, a number of truly Asiatic species that have penetrated into New Guinea, but these are for the majority restricted to its western parts, i.e. in the so-called Vogelkop (=Bird's Head) and down to Etina Bay, and to the Schouten Is. (=Biak), north of Geelvink Bay. Their number amounts to about 15% of the total. True Australian species are concentrated in the vicinity of Merauke and the south-eastern parts of Papua.



Distribution scheme of *Danaus affinis* (F.) in New Guinea and its vicinity. I. Area of *philene* group of subspecies; II. *mytilene* group; III. *bonguensis*; IV. *ferruginea* group; V. *affinis* group. ● = finding places, either checked or from literature, concerning subspecies belonging to I; + = same to II; o to III; .. to IV; x to V. Hybridisation areas are dotted.





Distribution of *Euploea (Salpinx) usipetes* Hew. of the *leucostictos* Gm. complex. Bismarck Archipelago left unconsidered.

In slight contradiction to this one will meet some species of both origins that have spread over the whole island, but this concerns those well-known quick migrants that settle wherever there is an opportunity. So a wallaby (*Dorcopsis*) was collected in the bush behind Humboldt Bay, and this small kangaroo will spread wherever grass fields come into existence as a result of human action, that is, through extensive cultivation of the land. The number of these species is negligible, though.

Now, turning our attention upon the internal faunistic structure of New Guinea, we will note a striking resemblance to the universally known condition of oceanic islands, for New Guinea abounds in local endemic forms. In most cases these have received the status of subspecies, but in other cases systematists consider them as full and valid species. There are lots of borderline cases too.

It will be evident that it makes a considerable difference whether a lowland or a mountain species is concerned: in the former the possibility of mixing with occupants of adjacent territories is nearly unlimited, and changes in appearance that indicate a genic divergence are seen only in long distances, in the latter a rapid succession of subspecies, phenotypically and genetically well distinct, may be observed, if the mountains are sufficiently isolated, for instance: by unsurpassable valleys, as in the tropics. With mountain species evolution works much more quickly. Accordingly, the minimum of change is reported in such species as have migratory habits.

Here follow some notes concerning the faunistic districts as we observed them.

I will begin with the high moors and desolate valleys of the Snow Mts., and gradually descend to the coastal plains.

As in the alpine districts of Europe and Asia, one would expect a rich alpine fauna in the valleys above the timber line, but regarding butterflies this was not so: there was caught no alpine butterfly to speak of! Many *Heterocera* were collected there, but this may be due to collecting them being so much easier in the open than in the thick forests somewhat lower down. As a matter of fact, many moths that were collected near Lake Habbema, at 11000', were also met with in the moss forest camp 2000'

below the former camp. In three months during a good sunny season we collected the poor number of eight species of butterflies, and only four of them were characteristic of the lake's environment. One of these, a Satyrid, was not observed lower down, and above 13000' not a single butterfly was ever seen. Similar things are found in *Hymenoptera*, *Orthoptera*, and so on.

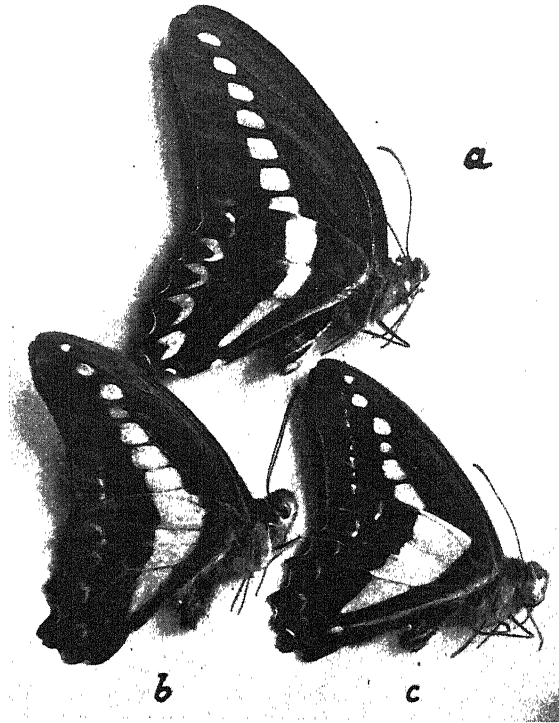


Plate 1. Duplicity of a *Papilio* in Celebes.

- a. *P. (Graphium) sarpedon milon* (Fld.), Malino, 3300', S. Celebes.
  - b. *P. (Graphium) sarpedon (monticolus) monticolus* Fruhst., Para Salamakki, Peak of Bonthain, 5600', S. Celebes.
  - c. *P. (Graphium) sarpedon (monticolus) longilineatus* (J. & Talb.) Tadjambu, 3200', inland from Palopo, Central Celebes.
- All specimens collected and photographed shortly after capture by the author, reproduced in natural size. Coll. Mus. Leiden.

This is abnormal indeed if one compares it with corresponding altitudes in the Himalayas, and we have consequently to look for an explanation of this abnormality.

It is generally agreed among geologists nowadays that the Snow Mts. are of young geologic age. The Dutch geologist W. K. H. Feuilleateau de Bruyn came to this conclusion in a paper: "Contribution à la Géologie de la Nouvelle Guinée", Lausanne (1921), and it was confirmed by R. W. van Bemmelen in "The Geotectonic Structure of New Guinea", issued in "De Mijningenieur", Batavia (1939).

Up to the Miocene this part of New Guinea was submerged, and according to Van Bemmelen the Snow Mts. became alpine not earlier than in the Pleistocene. Mt. Wilhelmina is now capped with a small field of eternal snow, but there are very few traces of moraine in lower parts, which should be found if it had had its present altitude of 15700' in the last glacial period. Presumably it was much lower then, and it is even highly probable that the summit zone, including the region that is now above the timber line, is a recent upheaval. The moor and fen districts, a kind of "no man's land" for butterflies, would have received their post-glacial fauna from the woodland parts lower down, and so the occupation is very sparse yet, the time for the development of many species by adaptation in divergent directions having been too short.

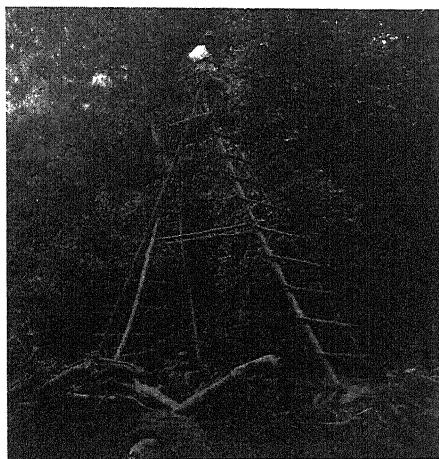


Plate 2. Collecting in New Guinea. *Araucaria* River Camp, 3000'. The scaffold has been built in front of a *Mussaenda* creeper in flower.

Another proof of the relative youth of the Snow Mts. is the antecedency of some rivers in this territory. The Baliem River, the head-waters of which are found west of Mt. Carstensz and which drains also the northern slopes of Mt. Wilhelmina, curves back to the main chain, breaking through it to the south where the mountain crest averages 13000'; and the Oeta R., being the outlet of the Wissel Lakes, does the same some 300 miles more to the west, where it breaks through the Charles Louis Mts., which are a continuation of the Snow Range. So these rivers are older than the mountains: along with the rise of the chain the rivers deepened their canyons.

Feuilleateau de Bruyn already assumed that the rise is still continuing together with a sinking of parallel stretches north and south of the Snow Mountains in agreement with the law of isostasy. This central upheaval involved the northern headlands, and whilst the Snow Mountains rose up in the geosyncline between Melanesia and Australia, the coastal plains of this northerly land became the high valleys which we now find everywhere to the north of the central chain.

In the Pliocene, i.e. before the rise started, East and West New Guinea must have existed as two large islands, but in still more remote periods these islands must have been linked together in one way or other: this is evidenced by the striking conformity

of their faunas, even when mountains species are concerned. It is most probable this connection existed along *the northern side* where a series of lower mountain chains are found near the coast and parallel to it. A decline, which has been dated about the Aquitanien (=Lower Miocene), broke up this connection and caused the coming into existence of an archipelago whose principal islands were the "Vogelkop" and Eastern New Guinea. The subsequent rise of the Snow Mountains has again welded together all these scattered parts.

What relation have these geological evolutions had with the existing fauna? And how has it developed ever since?

Species living in the high mountains lower than the timber line now got the opportunity of enlarging their domains by their occupying the newly risen territory starting from the east as well as from the west, and likewise have the smaller islands partaken of the repopulation of the Snow Mountain Range, insofar as these islands were in possession of high mountains. These mountain species, radically changed by a prolonged isolation, had by then developed subspecies up to the level of species, that is, where the offspring of the former uniform entity met, coming from east and west, they did not mix again, but existed independently of each other in the same surroundings. So in intermediate districts there originated a number of *species duplexes*<sup>1</sup>.

In the woodland southern slopes of Mt. Wilhelmina I collected two obvious doublets, one grouped round *Delias eichhorni* Roths., the other round *Delias leucias* Jord. In the former case the first component is directly related to *D. eichhorni* from Mt. Goliath to the east of Mt. Wilhelmina, the second to a yet unnamed subspecies from the Charles Louis Mts. to the west. They were both captured at the same altitudes between 8000' and 9500'. They are strikingly alike but show constant small differences. The second couple, the *leucias* doublet, consists of a higher and a lower component, to say it briefly. Over a zone of about 1000' they were captured in the same numbers. Unnecessary to tell that only a most accurate labelling on the spot enables me to draw these conclusions. In this case I am unprepared to communicate the place or origin of one of the components, but the other has surely arrived from the east.—Another case of duplicity in another district of New Guinea is the joint occurrence of *Delias niepelti* Ribbe and *D. meeki* Roths. in the westerly parts of the Owen Stanley Mts. Hybrids seem to be unknown. In some other cases I am still in doubt, and I have

<sup>1</sup> A species duplex is a species which is represented twice in the same district, by autonomous subspecies. This may be the result of a double immigration by subspecies that cannot interbreed or which are disinclined to interbreed in nature. In regard to the species complex, i.e. the whole compound of subspecies taken together, they both occupy the position of subspecies, i.e. of local representatives. In many cases the behaviour of the components of a species duplex have changed somewhat in course of time. Often a species duplex will consist of an old resident subspecies and a new intruder. The island of Celebes affords many instances of this phenomenon. One of these is *Papilio (Graphium) sarpedon*: the old inhabitant being *P. sarpedon milon* Feld. and the new immigrant *P. sarpedon monticolus* Fruhst. The former is a lowland form, that is met with up to 3000' of altitude, the other one may be caught upwards from about 1500' to about 5000'. In the hill zone between 1500' and 3000' both are captured. *Milon* shows the characteristic lengthened wing peculiar to Celebes butterflies, *monticolus* does not. *Milon* is found all over Celebes and has developed an outside subspecies in the Sula Islands, whereas *monticolus*, having apparently come from the south (*lugens* R&B. being its nearest relative) has not yet conquered the whole of Celebes, for it is absent in the northern parts, the so-called Minahassa. Being a mountain form, it has already established a subspecies of its own in Central Celebes (*longilineata* J & T) (Fig. 1). I bred both *milon* and *monticolus* from caterpillars found on the same individual plant at Malino, S. Celebes, at an altitude of 3000'.

often found very divergent subspecies of the same species flying at only a few miles distance from each other, so there may be an overlapping in other parts.

The same encounter and overlapping of subspecies has already been stated in birds, and Van Bemmél of the Buitenzorg Museum has recently published a case of two subspecies of a parrot, belonging to the genus *Alisterus*, which were both collected in the Weyland Mts. This also is an example of a recent infiltration without hybridisation.

Another problem concerns the valley of the Baliem River, the so-called Grand Valley. It stretches longitudinally north of the Snow Mts. and is walled off at the northern side by the high mountains south of the bank of the Idenburg R. Quite a series of such longitudinal valleys extend north of the Snow Mountain Range. Their faunistic products are most interesting, for here we have a number of "lost worlds" in the interior of New Guinea.



Plate 3. Baliem River Valley, 5500', in Central New Guinea.

Assuming the uplift of the Snow Mts. to have been in the last ages of the Tertiary period, we come to the conclusion that these high valleys were coastal plains before the upheaval, and it is then no longer astonishing that an important part of their animals are lowland species that have adapted themselves to the climatic conditions of an altitude of 5000' to 6000'. Of course most of the original occupants have died out, but each valley seems to have treasured its separate survivors, altered as if they were inhabitants of small ocean islands. Their isolation therefore must have been a perfect one. Besides the butterflies of the Grand Valley I have studied those from the Wissel Lakes and Araboe R. Valley collected by Boschma in 1939. Peculiar changes found in butterflies have their analogies in birds (Rand) and *Odonata* (Lieftinck). One of these Dragonflies, *Orthetrum sabina*, flies unchanged from N. Africa to the Pacific, but in the Grand Valley of the Baliem R. it has developed an aberrant subspecies. Even this migratory species must have been unable to communicate with its kind down near the coast, the canyon with its falls and stormy downpouring winds was too hard a barrier to overcome. So the small syngameon of early settlers continued

to breed in isolation, and this, as always, has stimulated deviation from the original stock.

Lower mountains and hills, in which New Guinea is very rich, show the remarkable fact that there are lots of subspecies proper each to a special system. Apparently these hill systems must have been isolated in an earlier period, and in the light of the archipelago theory we have to consider them all as former nuclei of islands. Such island remnants, which have now fused together, are Wandammen Mts. near the Geelvink Bay, Onin Peninsula in the south-west, the mountain mass south of Idenburg R., the Cyclops Mts. near the Humboldt Bay, and probably all other ridges of the Northern Divide Range, between Geelvink Bay and Astrolabe Bay.



Plate 4. Native hut in Moss Forest, 9000'. Such place abounds in *Delias*.

Lowland species remain unchanged over a considerable distance. For them Fruhstorfer (1907) considered four areas: Vogelkop, Central North, Central South, and Eastern New Guinea. The actual situation is, however, much more complicated because of the far greater mobility of lowland forms, and through a thing that was unknown to Fruhstorfer. There is namely a rise running longitudinally through the Arafura Sea and Torres Strait, that links Aru Is. with Merauke and Cape York, and which has had a bearing upon the fauna of South New Guinea. In this respect it will suffice to point to the distribution of *Euploea usipetes* of the *leucostictos* complex, the influx of red-headed races of the swallow-tail *Papilio* (*Polydorus*) *polydorus* (L.) within the territory of the true Papuan black-heads, the area occupied by the unmistakable Australian *Danaus affinis* (F.) against the other subspecies groups, and numerous other cases.

In this connection I want also to point to a rather striking conclusion at which Zeuner arrived in his elaborate study on *Troides* and allies (1943): "The eastern Australian subspecies *Ornithoptera priamus euphorion* Gray and *O. p. richmondia* Gray resemble in shape and coloration of the hindwing and in the absence of traces of the cubital green band on the forewing *O. p. priamus* (Amboyna) more than any other subspecies. Both differ in these characters considerably from *O. p. pronomus*

Gray ("a *poseidon* which has settled on Cape York Peninsula"), which is geographically their closest neighbour. *O. p. euphorion* and *richmondia*, therefore, appear to belong to an earlier stratum of dispersal of *O. priamus* into Australia. Whether this dispersal took place *via* New Guinea, or *via* the now submerged Arafura Sea and north-west Australia, cannot be decided." (l.c., p. 149).

I must reject the theory that the Northern Territory would ever have played a role of some importance in the dispersal of non-Australian species (as which I also consider *O. priamus* L.), and instead of the acceptance of a dispersal *via* New Guinea, in a very remote period, I offer the possibility of a connection *via* the Aru-Merauke ridge. In this light it would be of some interest to look out for remnants of relatives either

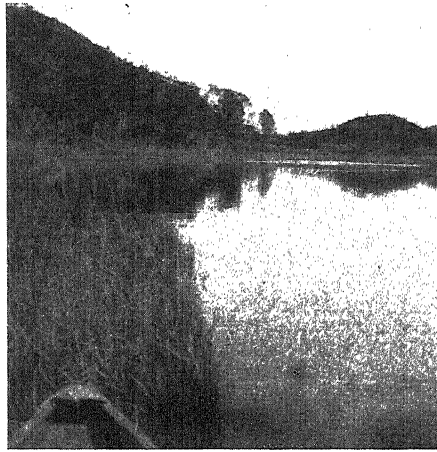


Plate 5. Lake Habbema, at about 11000'.

of *arruana* Fld. or of *euphorion* Gray amidst the *poseidon* community of Merauke. This will not be easy on account of the low subspecific variability against the rather high individual variability of Papuan *priamus*. The difference in genic respect is, however, illustrated by the fact that where local representatives of the *priamus* complex meet in New Guinea, the result is an increase of variability (*vide* p. 12).

*Papilio* (*Polydorus*) *polydorus* (L.) is one of the widest-spread of *Papilios* and at the same time one of the most susceptible as to the influence of isolation. The eastern greges or subspecies groups are tailless or toothed in the hindwing, the western groups are nearly all of them provided with a more or less lobate tail. These western forms have therefore received many separate species names, but *aristolochiae* F. and so many others are only manifestations of the archaic *polydorus*. It is not here the place to discuss this question, but I want to point to the inconsistency among Rothschild, Jordan and so many other authors, who have divided one species in a lot of separate entities entitling them specific rank (e.g. with *deiphobus* L., *gambrisius* Cram., and *polydorus* L.), whereas they granted the divisions of others (*aristeus* Cram., *eurypylus* L., *agamemnon* L., *sarpedon* L. etc.) their natural membership of one all-embracing complex, although the intrinsic value of the partition or union is equally questionable. Fruhstorfer, in his later papers, and Corbet, especially in his Danaid studies, have

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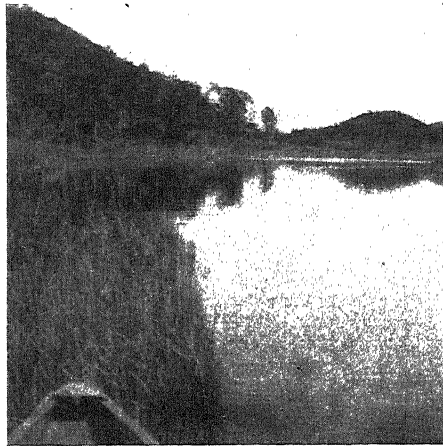


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advocated a far-going fusion of forms that may be very unlike externally, but are the representatives of one form of life in its space conquered.

I consider the Papuan tailless black-headed *Polydorus* as a subspecies group or grex, of the same standard as the red-headed ones that have a blunt tooth to the hindwing. The splitting up into subspecies is, owing to their commonness and the above-mentioned susceptibility, advanced to a point near that of the Apollo butterfly. With few exceptions I think this is justified, and I was able to check all these local forms (whose localities have been entered in map no. 1) with only five exceptions: *leodamas*, *meforanus*, *vulcanicus*, *dampierensis*, and *voluptitius*. I even had to add another subspecies to the host of blackheads, namely *mamberamus* n. subsp., which differs from *humboldti* Roths. in the large and conspicuous tornal red spot of the upperside of the hindwing, by which characteristic it stands separate amongst all other New Guinea subspecies. (Types in Museum Leiden, leg. Van Heurn on the banks of River Mamberamo, one paratype in Museum Buitenzorg, Araucaria R., leg. author).

Subspecies beyond New Britain have not been listed in the series of the map, likewise have the red-heads from Buru and Sula Is. been omitted as being irrelevant. The dubious subspecies *voluptitius* Fruhst., described from an unknown habitat, I have provisionally placed in the Fly R. basin, because it has, according to its description, so many affinities to *auster* v. E. that it must have come from somewhere in the great southern plain of New Guinea. The red-headed subspecies *orinomus* Roths., was supposed to inhabit the hill country of the interior behind Port Moresby, but I have seen a series from Yule I. (coll. Jurriaanse in Mus. Leiden) and from the Digul R. (Mus. Buitenzorg), and so it is not a highland subspecies of the Papuan subspecies group.

When comparing *orinomus* with *queenslandicus*, we observe a striking similarity of wing form and colouring. All black-headed *Polydorus* from New Guinea, that is: the *godartianus* group of subspecies, have a coal-black upperside, the red-heads, from Buru to Sud-Est I. are sooty black. The *orinomus* specimens that I have studied all showed a yellowish tint of the discal spots of the hindwing, and this is pure white or creamy in the *godartianus* group.

The distribution schemes of *Euploea usipetes* and *Papilio polydorus* of the *polydorus-queenslandicus* section being so alike cannot be merely accidental, and it is corroborated by the occurrence at Merauke of numerous other Australian forms, either species that have no further dispersal in New Guinea, or subspecies that are more nearly related to the Australian than to the other Papuan forms. On the other hand, Aru subspecies have, to my knowledge, never been compared satisfactorily with those from the Digul R., Fly R. or Merauke, and apart from the above two species, and a few other butterflies, I have no further evidence regarding the dispersal by means of the now submersed ridge.

The fusion of the islands of the pleistocene Papuan Archipelago brought subspecies in contact that had changed less than those belonging to mountain species, and which mostly could still interbreed. So hybridisation took place at the boundaries. This has been demonstrated already in birds by Hartert, Knud Paludan, Rothschild and Stresemann in their paper (1936) on the birds of the Weyland Mts. collected by Stein. These authors most carefully considered the areas of distribution of each species and so found subspecies hybridisation in the case of some of them, in certain boundary districts. One of these districts is the southern bend of the Geelvink Bay and along the coast to the Siriwo R.<sup>2</sup>

<sup>2</sup> *Ducula pinon*, l. c., p. 185.

This same district is apparently also one of the subspecies hybridisation areas of butterflies. I have not been there myself, but have seen specimens in the Leiden Museum and found many indications in literature.

*Delias aruna* (Bsd.) is an example of a species having two separate subspecies, a northern and a southern, in New Guinea, strikingly different and very constant, with the exception of the so-called subspecies *roonensis* Roths., which exhibits all intermediate forms between the extremes. It was found in the Wanggaar plain on the southern coast of Geelvink Bay. The different forms were represented in colours in Talbot's Monograph on *Delias*.



Plate 6. Wamena River Valley, 11500'. The Wamena R. is a tributary to the Baliem R. Its valley is bordered by a thick forest of tree ferns. Mt. Wilhelmina dimly in the background, centre.

Another instance is *Ornithoptera priamus* (L.), the females of which show an exceeding amount of variability in some places, although they are rather constant in intermediate regions. One of these places of excessive variability is a broad stretch ranging from the southern coast of the Geelvink Bay to Fak-Fak on the south side of the Onin Peninsula. One of the aberrant forms was named ab. *kirschii* Oberth., and Fickert, in Zool. Jahrb. 1889, called it "hahnenfedrig" (=cock-feathered), because it displays the green colours of the male to some degree. The Leiden Museum possesses some of Kirsch's ♀ aberrations from Fak-Fak and other places of the Onin Peninsula.

*Danaus affinis* (F.), which has five well-distinguishable groups of subspecies in New Guinea, each of them locally rather constant, shows an excessive variability in just the same places as the *Ornithoptera*. This inconstancy of outlook was first observed by Joicey and Talbot (Ann. Mag. Nat. Hist. (9), 16, 1925) for the district south of Manokwari on the slopes of the Arfak Mts., where two of the subspecies groups of *affinis* came to a clash, and also for Ceram Laut and Gèser I., where two other subspecies of *affinis* got mixed up. The same species further shows an excessive variability at Babo, on the Mac Cluer Gulf. Not two specimens are alike in the long series from that place in the Buitenzorg Museum (1940 Lundquist), and many of them show

features that are unlike any other form known from New Guinea. The same phenomenon can be observed with the series from Wendisi on the south-west coast of the Geelvink Bay (coll. Jurriaanse of the Leiden Museum), and from Fak-Fak in the principal collection of that Museum. Many subspecies groups of *affinis* are found overlapping the territory of an adjacent subspecies group, but the species being of little value in the eye of collectors owing to its commonness and plain colours, made that information is scarce as to the various forms in the districts of double occurrence. I have outlined the distribution of the subspecies groups of the *D. affinis* complex in New Guinea and its vicinity, in map no. 2, however, without going into detail. It contains all the information I could get, either from literature, or from specimens studied.

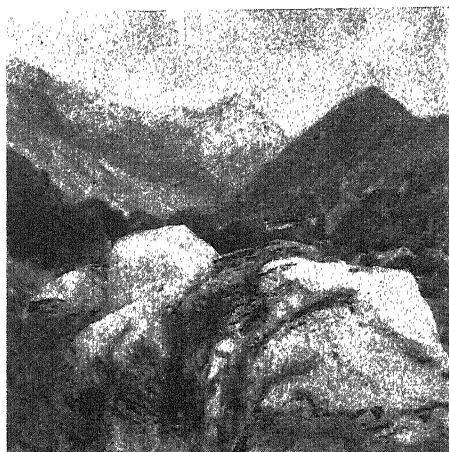


Plate 7. Mt. Wilhelmia. The summit (in the centre) is at 15750' of altitude. Rich alpine flora between the boulders, but no butterflies. The valley at the background is the Scree Valley, at the entrance of which was our camp site.

Other districts of New Guinea where some species of butterflies show a similar undisciplined behaviour, are the environs of Hollandia, the region between Astrolabe Bay and Huon Gulf (Hagen blamed climatic conditions for those faunistic differences which he also observed), and part of the great Southern Plain. More boundary districts with a hybrid fauna will come forward as soon as rich collections with sharply labelled series shall become available.

The parallelism between birds and butterflies regarding the distribution of their subspecies and the similar conduct of these subspecies point to a general principle underlying this matter, which in my opinion must be the geological evolution of New Guinea.

Connections of the New Guinea butterfly fauna with the outer world are in accordance with Van Bemmelen's conception of the island's origin, namely *the northern parts as a borderland of the sunken Continent of Melanesia*.

This continent still existed in Mio-Pliocene times, when New Guinea slowly began to rise from the deep geosyncline between Australia and Melanesia. It is from Melanesia that in my opinion the bulk of the Papuan fauna (and its most typical part) may have

originated. The fauna of the western Pacific islands still shows many affinities to that of New Guinea.

How and when the western connection did exist, that provided the Bird's Head with its high percentage of Malayan forms, and on the other hand, the Philippines and Celebes with their Papuan forms, is uncertain as yet. The same with the direct connection between the Tail of New Guinea and Queensland, which has evidently existed independently of the Merauke-Aru Ridge that linked Cape York with the Key Islands and so with the Southern Moluccas.

To summarise my conclusions, I state herewith:

1. that New Guinea has no real Australian fauna;
2. that the Sahul shelf has played no important role in the faunistic occupation either of New Guinea or of Northern Australia;
3. that, presumably during the last glacial period, the Merauke-Aru Ridge existed as an actual land connection, which allowed the dispersal of species from the Outer Banda Arch to Cape York and conversely;
4. that about that period the Snow Mountains rose to alpine heights, in the mean time linking the scattered islands of the then existing Papuan Archipelago;
5. that this condition as an archipelago has been very advantageous to the development of species in New Guinea;
6. that the lowland species of the high valleys situated on the north side of the Snow Mountains are relics of a fauna that once occupied the coastal lowlands to the north of the deep geosyncline from which the Snow Mountains arose, having adapted themselves to the prevailing conditions of high altitude, and having bred on in perfect isolation since the Snow Mountains became alpine.

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## THE DIVISION OF LABOUR IN THE ANTS

By Derek Wragge Morley

Social life in animals seems to be correlated with one prime factor—the female having experience of her young. In all social animals the female survives until after the young have reached the adult stage. In the ants and the other truly social insects the female usually survives through several worker life-times.

In the higher ant societies (e.g. the *Formicinae*) the function of the female is restricted to reproduction and comparatively few females are present in a colony. The male is reduced to a mere cipher in the reproductive cycle. Thus the most important factor in the social life of the ants would seem to be the corollary of that stated above—the progeny (the worker ants) having experience of the living mothers. (There is usually more than one fertile female in each nest). Only the females can lay the eggs which will give rise to further ant mothers on whom the future of the colony will eventually depend. They represent the fertility of all the workers in the colony, and if the females are killed the colony soon dies out.

The ants present us with a more or less complete picture of this sociological development, from the colonies of the primitive *Poerinae*, where the female is undifferentiated from the worker and where males and worker-females all share the common labour of the colony, to those of the *Formicinae* described above. Closely coupled with this limitation of the functions of the female is the development of the society from a loosely knit carnivorous hunting unit consisting of a few individuals to a unit of extreme social complexity consisting of many thousands of worker individuals.

The phylogeny of ants is complex and several major lines of evolution can be traced. The evolution of some of these lines has been arrested or limited at various stages of social development. For example the Doryline army ants have been limited in their social development and have developed a nomadic life and retained a carnivorous feeding habit. Yet they have reached a high degree of polymorphism with a well-differentiated soldier caste. The mental development of the individual and the social development of the whole colony are, however, of a low order.

In the same manner the primitive Ponerine ants living today represent a failure of social and individual development at an even earlier stage, although the *Leptogenyini* represent a stage of parallel development to that of the *Doryline* without, however, their polymorphism. The two major lines of ant evolution are represented by the *Myrmicinae* and the *Formicinae* and it is in these two very distinct groups of ants, that the highest degree of social behaviour is found. Although it is in the *Myrmicinae* harvesting and fungus-growing ants that the highest degree of polymorphism is attained, it is in the Monomorphic *Formicine* ants that the greatest division of labour and social cohesion occurs. It is in the *Formicinae* also that the individual ant attains its highest degree of plastic behaviour.

Huxley (Ants, London 1936) has stated that “the major part of the division of labour in insect society is pre-determined by the structure of the body and the brain.” That this statement in its widest applications is correct will be demonstrated, but it should be realised that the polymorphic worker forms occur in only relatively few ant societies and that those are not the ones in which the development of the social integration reaches its highest development. Certainly this statement is

not accurate in quite the sense that Huxley meant it. Miss Buckingham (1911) has shown that there is in general a difference of behaviour in thriving colonies of *Pheidole* between the soldier and worker, the former acting as a sort of physical reserve and only becoming active when the colony is attacked or unduly excited. It is however amongst the less clearly differentiated worker class that the social cohesion and division of labour is most striking and here Miss Buckingham could find no marked differentiation of behaviour between the larger or smaller *Pheidole workers*. In the *Formicinae* there is less size difference amongst the workers and in some cases, including those species which exhibit the most marked development of the division of labour, there is hardly any polymorphism and it can be discounted as an important factor. Where the soldier and other markedly polymorphic forms occur they may instinctively fulfill certain functions such as guards in *Pheidole*, or janitors in *Colobopsis* blocking the entrance to the nest with their specially developed heads—but this does not affect the major problem of the division of labour.

Why do certain ants occupy themselves fetching food and others building or caring for the young at any one time? Why do some ants build sheds of earth over the aphides on the leaves near the nest while others milk them (See fig. 1.) and yet others bring them from outlying leaves into the better protected pastures? Why do not all the ants visit a large source of food nearby of which many individuals engaged on foraging further afield, or nest-building, or aphid-tending known to be aware. In fact why do they all seem to work so coherently as if with purpose, for the common

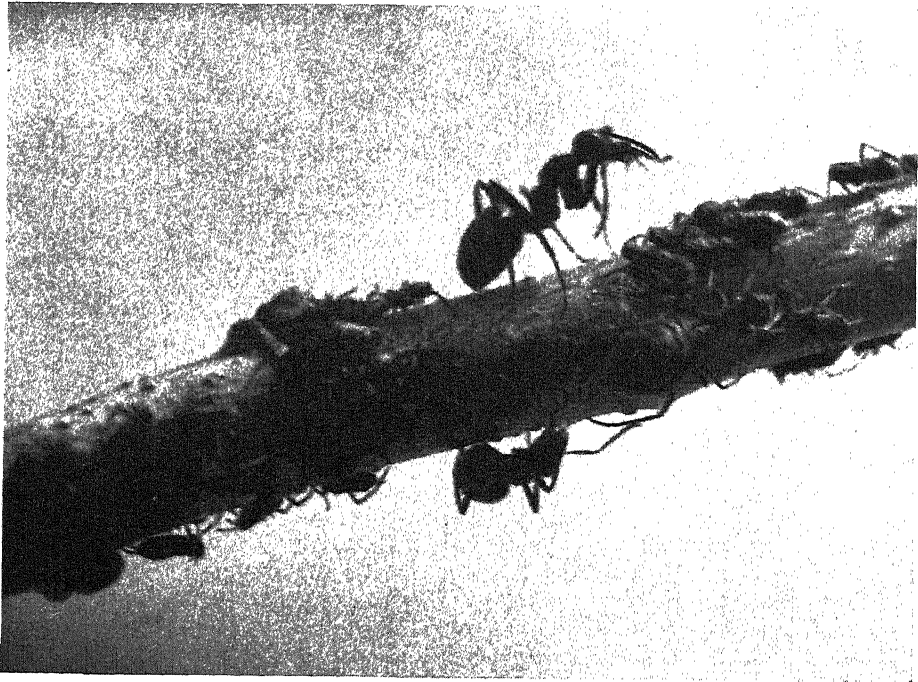


Fig. 1.



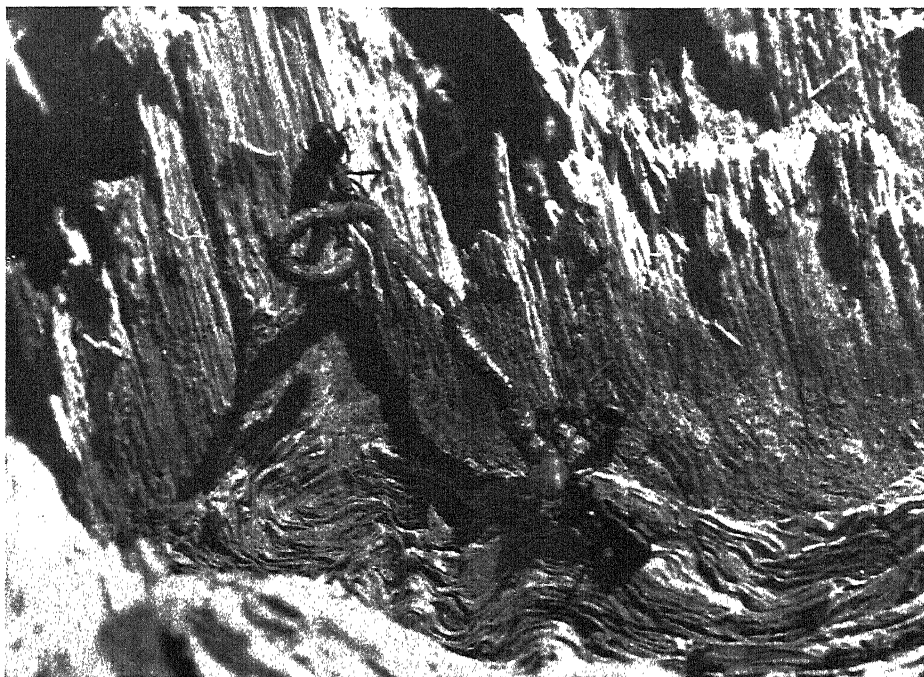


Fig. 2.

social good? (See figs. 2 and 3.) This is the problem which has so perplexed philosophers and scientists throughout the ages.

The striking factor is that the individual plasticity of behaviour of the ant, and its ability to learn (e.g. the experiments of Schneirle and the present author with ants learning mazes) are greatest when the social integration is greatest. That the most successful ants should exhibit the highest degree of individual behaviour is to be expected, yet the fact that these two apparently contradictory phenomena reach their peak together has appeared to many surprising.

Another remarkable phenomenon is that the stridulatory (sound-producing) organ of the ants, which is well developed in the primitive *Ponerinae* has atrophied in the *Dolichoderinae* and *Formicinae* (See Wragge Morley 1939).

More careful scientific study of animal behaviour has only added to the puzzle since it is clear that whatever mechanism is involved must be one of extreme simplicity, and one which will not put undue stress on the workings and the brains of the ants.

Such loosely-worded concepts as Haskin's "social pressure" (1939) are of little use and anyway can only be said to provide the motive force behind the action of helping the colony, as also does Wheeler's "inherent hunger" of the worker caste. The former has little meaning being an anthropomorphic concept; the latter is a scientific make-shift which does not fit the facts.

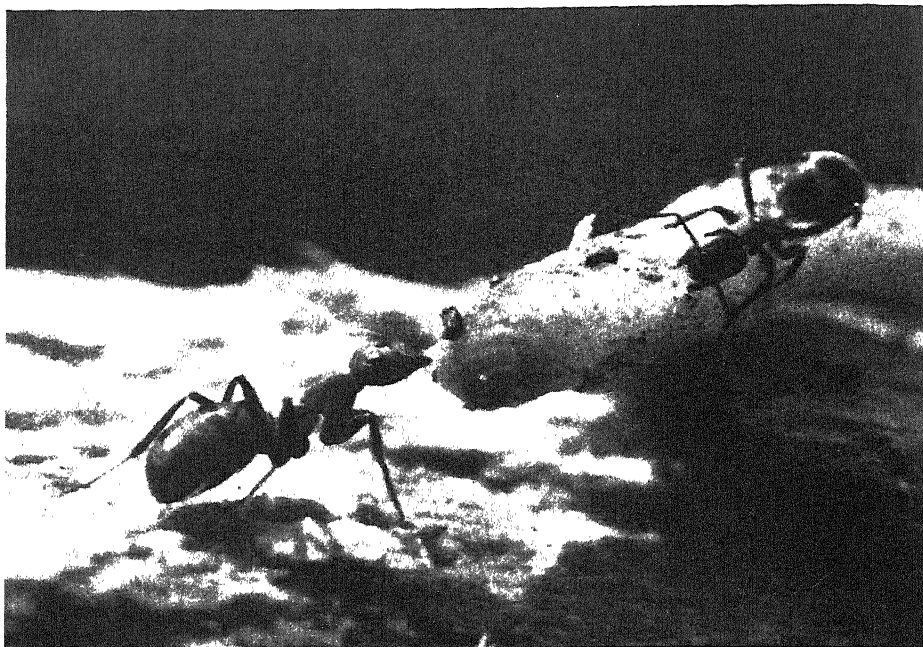
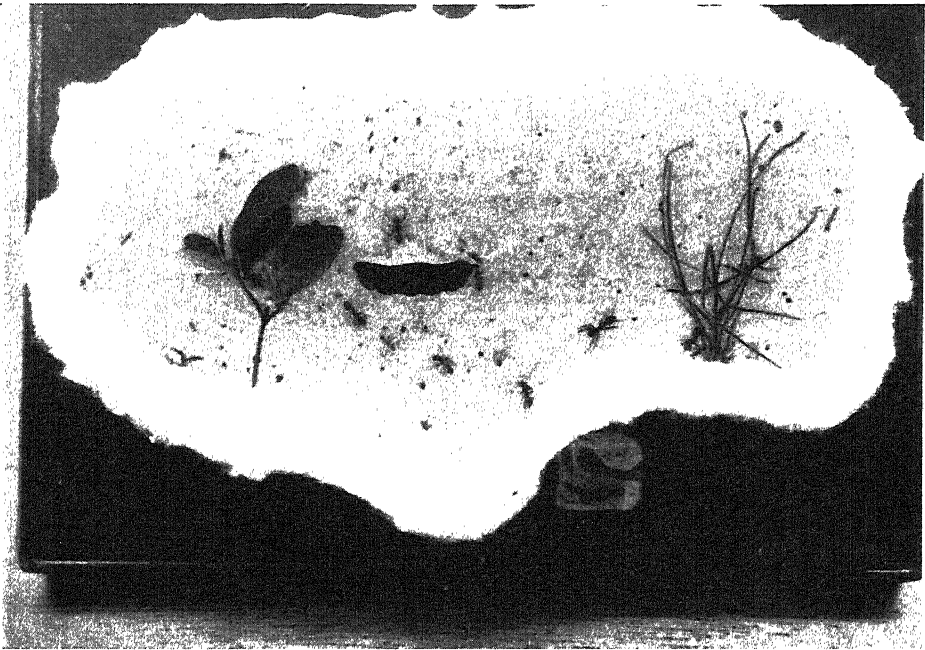


Fig. 3.

Examination of different species of ants in a plaster of Paris arena where a nesting place and an open space in which different possible occupations and food sources are provided, yields interesting information (See fig. 4).

In the more primitive species (e.g. *Myrmica* sp.) the ants when released from the nesting place leave at once in a body and pour into the arena (See film "Britain Today No. 27" 1948. Merlin Film Co. for Central Office of Information). No workers remain behind with the queen or queens which themselves may leave the nest. Each individual ant forages over the whole area of the arena wandering from food source to food source or activity to activity, and eventually returns to the nest. A trail may be set up after a long time to one major food source, but the general picture is one of each for himself and little cooperation. Few ants remain with the brood and there is little nest-building activity. With more primitive genera than *Myrmica* the lack of cooperation and the solitary foraging and meandering is even more striking.

In the case of a Formicine ant on the other hand (e.g. *Formica fusca*, *Formica rufa* or *Camponotus* sp.) the picture is markedly different. On the opening of the orifice of the nest only a single ant, or at most one or two will at first sally forth, only to return after a brief investigation of the territory. Later the same ant or ants will again come out in the arena together possibly with one or two companions. Soon the major sources of food and the various possible activities are discovered and soon trails will be formed leading to and from the nest. (See fig. 4.) There may be a brief period of general investigation by a large number of individuals before the setting up of trails, but it is only very brief.



*Fig. 4.*

When different occupations are provided it is found that some individuals more frequently initially investigate these than others, furthermore these same individuals tend to commence routine occupations more frequently than other individuals, drawing other ants into similar activity. It is of interest that if these individuals are selected and tested in maze-learning they generally exhibit greater learning ability than the average nest mate. (See Wragge Morley "The investigation of the learning ability of ants" *ibid.*; and the film already cited).

What then is the explanation of these phenomena? Each individual ant is a complex of instincts, learning and varying degrees of mental plasticity, being bound to its fellow member of the community by the common fertility of the ant mothers which it shares with them. It reacts to the outside stimuli it receives in a markedly similar manner to its fellow workers, being physiologically and instinctively similar, yet with slight individual differences due to the degrees of different instinctive and physiological inheritance. The individual worker is in constant contact with its fellow workers and this close contact coupled with the emotional bond of frequent reciprocal regurgitation, the common fertility bond of the females (queens) and its physiological, mental and environmental similarity to them, leads to a most intimate physical and mental relationship. Thus when one worker reacts to any stimulus this reaction has an immediate effect on the other worker in close proximity to it which are not already reacting more strongly to another stimulus. (This is very clearly seen in the arena experiments). No method of communication other than the most primitive gesticulatory system as found in the tapping of the antennae and "saluting" together with the noticeable instinctive

reaction of the worker concerned to some stimulus, as for example hunger, feeding the young, or building, is necessary in order to cause workers to be attracted by it to that operation.

That the very physical excitement caused by alarm may act as a local stimulus in this manner is shown by the reaction of the soldier of *Pheidole* (See above). Cunliffe Barnes (1941) has also observed similar reaction to the sheer physical excitement of individual workers in captive colonies. Schneirla (1944) has described how the queen of the nomadic *Eciton* may cause excitement when she appears from the bivouac and excites the workers to set out on the trail. Thus one worker reacting to hunger will leave the nest and forage exciting others not already engaged by a stronger stimulus to do the same. Another worker being near a part of the nest where building operations are required will be stimulated in a similar fashion with similar effects. Many individual workers will react in this manner to the various stimuli encountered in and around the nest, and each of these workers may be termed for convenience an "excitement centre." (See Wragge Morley Nature 1947).

The strength of each excitement centre weakens as the stimulus is satisfied and as more and more workers are brought in the particular action concerned. Thus the fifth worker to engage on the task as the result of the attraction of any one excitement centre will be more easily attracted to another activity by a different excitement centre ant than the fourth or the third.

It will be seen that this mechanism also has applications within the various operations, for example in causing individual ants to build at different points or to engage in different types of building operations, in influencing foraging in different areas and at different distances from the nest, or in governing the fulfillment of different operations in caring for the queens or brood. Thus licking the larvae may change, when signs of hunger are reacted to by another worker, to the operation of fetching food, or with another stimulus to moving them to a more humid chamber. In such cases some workers may still engage in the activity stimulated by the older "excitement centres", even after the original excitement centres themselves have been counter-attacked. For example the latter event may often occur when the original excitement centre's reaction to the original stimulus has been satisfied while that of some of the later attractees has not.

In foraging the returning ant bearing food may equally well act as an excitement centre for that operation as the hungry ant leaving the nest.

Individual habit, learning and the various interactions of the excitement centres constantly altering and being recreated on the trail will account for its distance foraged by individual ants and their attraction to or passing by of food found near the nest. Chen (1938) demonstrated the existence of show-working or "lazy" ants and fast-working or energetic ants and these and other similar factors will also have an effect in the manner of reaction of individuals in the various operations and the degree of their affectiveness as excitement centres. Sometimes where many individuals degree of their effectiveness as excitement centres. Sometimes where many individuals may appear. This may happen in the emigrations of *Formica rufa* L. to a new nest site (See Wragge Morley 1939), but the balance of the excitement centres is soon restored together with the normal social cohesion.

In the case of slaves of the slave-making ants the shared fertility is by adoption, the adult slave workers having known no other ant-mothers than those of the slave-makers.

Thus the organic type of society, where there is unequalled social integration and a beneficial division of labour, is achieved in the ants by simple responses underlying a complex series of interactions between the individual ants of the colony and between groups of individuals, all linked by the major common factor of a shared fertility.

The variation in the individual mental factor of the ants—instinct, learning power, experience, degrees of reaction to stimuli etc.—is often great, but the resultant social integration is unaffected.

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## SECTION IV

POSIBILIDAD DE DETERMINAR LEPIDOPTEROS EN ESTADO DE PUPA,  
MEDIANTE ESTUDIO DE LOS APARATOS GENITALES

Por R. Agenjo

La técnica de determinar lepidópteros, mediante el estudio de los aparatos copuladores masculinos, iniciada por Rambur en 1842, se ha popularizado bastante en los últimos veinte años. El citado entomólogo francés, empleó por primera vez dicho procedimiento, para establecer la diferenciación de las especies de *Pyrgus* Hb., (= *Hesperia* F.) tratadas en la Vª entrega de su *Faune Entomologique de l'Andalousie*, obra hasta hace seis años rarísima y desde entonces puesta al alcance de los estudiosos, mediante una segunda edición, lanzada con notoria oportunidad en el centenario de la aparición de la primera, por el Instituto Español de Entomología del Consejo Superior de Investigaciones Científicas.

Mucho menos practicada es la determinación específica de los lepidópteros, mediante el examen de los aparatos genitales de las ♀♀ y eminentes investigadores que acostumbran a estudiar y describir con exactitud las armaduras copuladoras de los ♂♂ y a fundar géneros e incluso familias, basados en las analogías y diferencias de dichos aparatos, parecen olvidar, que los insectos tienen dos sexos y que como he puesto en evidencia algunas veces, ocurre en ocasiones, que los caracteres ofrecidos por las genitalias femeninas son mucho mas destacados que los que presentan las masculinas. En magníficas y modernas monografías, se dan caracteres, claves y hasta figuras de andropigios, para diferenciar los ♂♂ de determinadas especies, sin hacer indicaciones respecto a las de las ♀♀, con lo que tales trabajos quedan necesariamente incompletos, ya que para conocer y diferenciar bien las especies de un género es preciso poder separar sus ♀♀ mediante caracteres de la misma jerarquía taxonómica que los utilizados para discriminar a los ♂♂. Los autores que establecen géneros fundados en analogías o diferencias de los andropigios, sin tener en cuenta los caracteres de los aparatos genitales femeninos de las especies que consideran, olvidan el juicioso parecer de maestros como Joannis y Meyrick, que sin aludir concretamente a órganos reproductores, entendían, no deben establecerse géneros con caracteres que aparezcan solo en los ♂♂ de las especies estudiadas, sin que sus ♀♀ los ofrezcan, o a lo menos—agrego yo—posean otros convergentes. Y con respecto a la genitalia, puede acaecer en efecto, que determinadas especies ofrezcan caracteres en sus andropigios que permitan agruparlas en categorías taxonómicas superiores, pero cuyos aparatos genitales femeninos resulten heterogéneos y en cambio estén en determinadas proporciones, emparentados con los de otras, a su vez incluidos en géneros distintos segun las armaduras de los ♂♂. Que razón habría para incluir como congéneres mariposas en tales circunstancias? Por qué con el mismo fundamento, no podrían agruparse en géneros distintos, según los caracteres de las genitalias femeninas? Contra este evidente peligro es necesario precaverse y no establecer géneros basados únicamente en los caracteres de los andropigios, sin comprobar antes la homogeneidad de los aparatos genitales femeninos de las especies que se trate de agrupar, o por lo menos que no puedan a su vez conjuntarse

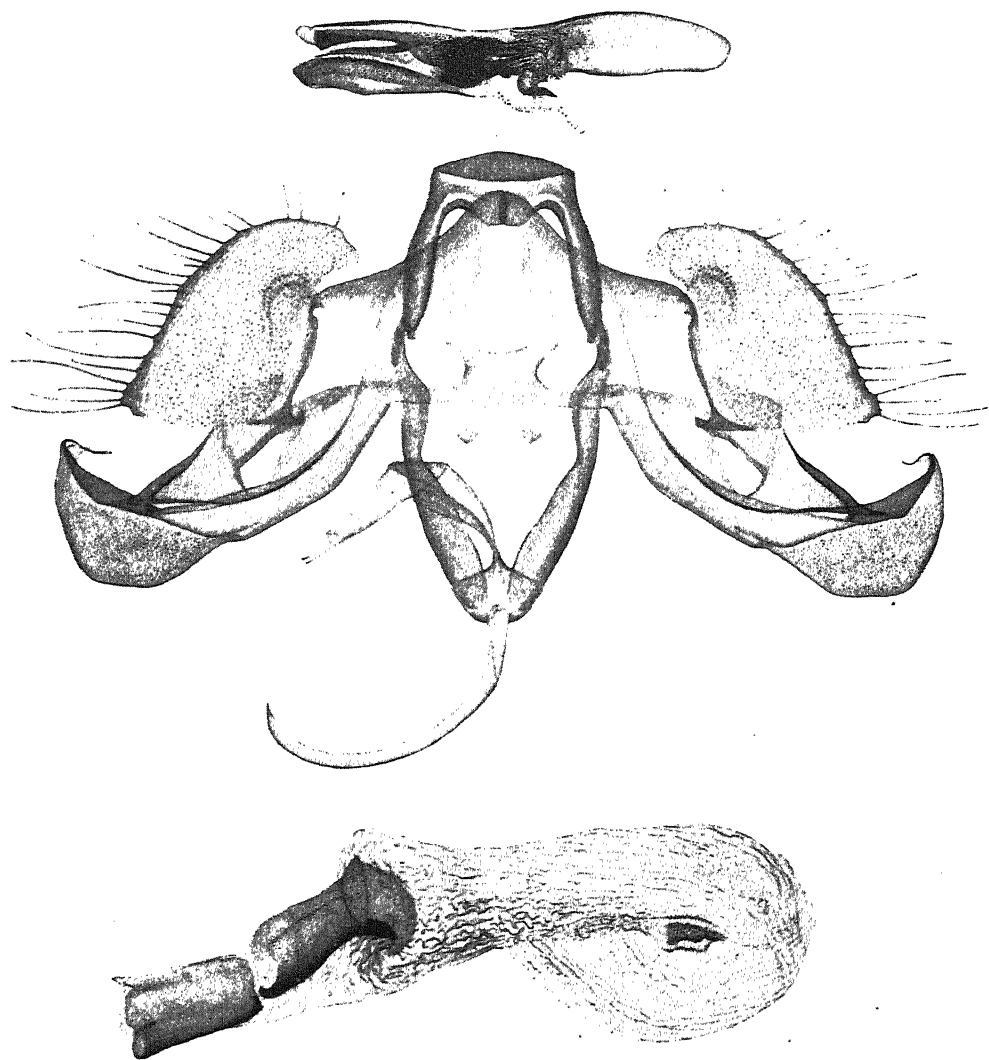


Fig. 1. — Andropigio de *Prodenia litura* (F.) con el aedoeagus separado.

Fig. 2. — Ginopigio de *Prodenia litura* (F.)

en determinadas proporciones, con los de las ♀♀ de otras situadas en géneros diferentes establecidos por analogía de órganos copuladores masculinos.

La clasificación y determinación de lepidópteros mediante examen de los caracteres externos, lleva en muchísimos casos a resultados erróneos. Las descripciones de especies, basadas en caracteres de dibujo y color de las alas, forma de los palpos, antenas y patas y la representación de estos insectos mediante figuras coloreadas no sirven casi nunca para efectuar clasificaciones y determinaciones seguras. En cambio las llevadas a cabo examinando los aparatos genitales son siempre certeras. Esto se debe a que el aspecto externo de los lepidópteros es engañoso y los pelos y escamas, son muchas veces máscara que desfigura los verdaderos caracteres de tan atractivos insectos. Los colores y dibujos alares que en ciertas especies de mariposas, cambian poco, en otras y sin que se sepa por qué varían extraordinariamente. Y por desgracia, la mayoría de los lepidópteros han sido descritos teniendo sobre todo en cuenta el aspecto de sus órganos de vuelo. La genitalia en cambio no varía dentro de los individuos de la misma especie y ofrece un asombroso proteísmo a través de todas ellas, sin perjuicio de que las de las especies muy próximas presenten una relativa relación de parentesco, lo que permite a veces, reunir las en géneros más o menos homogéneos y en casos ya más raros hasta establecer subfamilias y familias. Las formas individuales que los autores antiguos y aun algunos modernos llaman aberraciones y que yo durante algún tiempo también designé como variedades, planteaban siempre el problema de si se trataba de verdaderas especies o eran simples formas no transmisibles por herencia, y en este último caso había que dilucidar a qué especies pertenecían en realidad. Con el empleo de la genitalia tales vacilaciones quedan por completo eliminadas. Las formas individuales, por muy desconcertantes que sean, debido a su aspecto externo, se adscriben siempre, mediante el estudio de sus órganos sexuales a la unidad específica a que en realidad pertenecen. Incluso los individuos total o parcialmente pelados y desescamados y completamente irreconocibles por sus dibujos y colores alares pueden ahora mediante los estudios anatómicos apropiados, denominarse con absoluta certeza.

Lo que antecede tiene un interés extraordinario si se trabaja en el estudio de faunas locales y cuando se trata de plagas. En el primer caso, no se corre el riesgo de tener que silenciar una especie recogida en el territorio de caza que se está estudiando, porque el estado del ejemplar que la represente la haga irreconocible a primera vista. En el segundo, los centros fitopatólogos asesores, tanto agrícolas como forestales, pueden contestar rápidamente a las demandas de auxilio formuladas por particulares, cuando estos solicitan ayuda para combatir a los lepidópteros que diezman sus cosechas o arruinan los montes. Los agricultores y silvicultores, no tienen por regla general, práctica de recoger insectos y cuando consultan lepidópteros productores de daños en sus plantaciones, si remiten adultos, los suelen mandar muy mal conservados, lo que hace penosísimo y a veces hasta imposible, si solo se les examina externamente, aproximarse siquiera en las determinaciones, a las especies de que se trate. En cambio el estudio de las genitalias puede realizarse siempre, por muy desescamado que esté el lepidóptero remitido. Conocida por los centros aludidos, la biología de las especies productoras de plagas y los medios de combatirlas, logran prestar rápida ayuda a los agricultores y silvicultores, teniendo series de preparaciones de todas las especies que son o pueden llegar a ser peligrosas. Al recibirse en los centros de investigación correspondientes, los ejemplares consultados, se determinan inmediatamente, merced a la comparación de sus genitalias con las poseídas en el establecimiento asesor de que se trate, y en su virtud es posible comunicar en seguida a los consultantes, los tratamientos adecuados



para suprimir la plaga antes de que destruya plantaciones o perjudique las inmediatas cosechas. Este método ha sido seguido en los Estados Unidos con halagüeños resultados.

Desgraciadamente con tanta o mas frecuencia que los adultos se consultan a veces orugas y pupas. Las primeras, no pueden ser determinadas por genitalia ya que carecen de ella, pero no sucede lo mismo con las segundas, por lo menos en una respetable proporción, motivo que me ha inducido a escribir este artículo.

Con frecuencia cuando se crían orugas desconocidas, para el que de esto se ocupa, se consigue que se transformen en pupas, pero a veces, no se logra que de ellas salgan los imagos. Asi me ha ocurrido a mi en diversas ocasiones y en tales casos como resulta difícil sean crisálidas o pupas muy características, lo ordinario es considerar fracasada la cría y renunciar a averiguar la especie de que se trataba. Sin embargo, ya hace varios años, despues de alimentar orugas de una *Cucullia* que encontré en el monte de Santiuste, término de Pampliega, en la provincia de Burgos hasta conseguir una pupa, esperé ansiosamente la llegada de la primavera siguiente, muy interesado en conocer que especie habia recogido. Pero a pesar de que el *Agrotidae* aparecía bien delineado bajo su cutícula pupal, no conseguí verlo salir de ella y comprobé estaba muerto. Rompí entonces su exuvio y como el adulto aparecía ya desarrollado, me ocurrió macerarlo en potasa; y despues de hacerlo, intenté la disección de su genitalia, lo que conseguí con pleno éxito, encontrando pertenecía a un ♂ y que estaba perfectamente formado. Absorbido entonces por el estudio de otros problemas, no me volví a ocupar de tal cuestión, pero en el mes de noviembre último, recibí de mi querido amigo D. Manuel Mendizábal, Director del Instituto de Xeroaclimatación de Almería, adscrito al Consejo Superior de Investigaciones Científicas, una caja conteniendo pupas y orugas a medio transformar del *Agrotidae*, *Prodenia litura* (F.) que causa plagas en algunos términos de la provincia de Almería y es especie poco representada en la colección de Lepidopteros de España del Instituto Español de Entomología, por lo que yo la habia pedido a Mendizábal. Los insectos venían entre tierra y temiendo que el calor del laboratorio perjudicase su evolución, los trasladé a una jaula expuesta al aire libre. Pasado el tiempo en el que debían aparecer los adultos, sin conseguir la salida de ninguno, procedí a examinar todos los ejemplares, encontrándolos desecados: unos en trance de transformación de orugas a pupas con los anillos correspondientes al abdomen de estas ya formados, pero conservando las patas torácicas y la cabeza de larvas, y los mas completamente desarrollados.

Recordando mi observación sobre la pupa de *Cucullia* que ya he referido antes, decidí intentar la disección de los órganos genitales masculinos y femeninos de los ejemplares almerienses que eran doce en total, y encontré en las pupas ya formadas, que los aparatos aparecían bien definidos y concordaban con los de los adultos de otras procedencias, aunque algunos estaban menos quitinizados que lo habitual en *litura*, mientras que en los individuos con la cutícula pupal del abdomen perfectamente constituida, pero conservando las patas torácicas y la cabeza de oruga, no existían trazas de órganos copuladores y si en cambio histoblastos, botones o discos imaginales, perfectamente visibles.

La existencia de los discos imaginales es bien conocida y ya se sabe empiezan a originarse por un pequeño pliegue y espesamiento de la hipodermis y que tienen la potencialidad de los tejidos embrionales y dan origen en los insectos a toda clase de apéndices y por consiguiente al aparato genital. Sin embargo sería interesante precisar bien, cuanto tardan en formarse estos órganos dentro de la pupa y si tal lapso varía

bastante de unas especies a otras. Desgraciadamente, no tengo ahora tiempo para estudiar el problema que reputo de gran interés.

No pretendo de ninguna manera indicar que he descubierto la existencia del aparato copulador en las pupas de los lepidópteros, pues esto será sin duda perfectamente conocido por los entomólogos dedicados al estudio del desarrollo de los insectos, pero creo lo ignoran muchos lepidopterólogos que practican la técnica de la genitalia, ya que nunca he leído en la literatura nada, sobre determinación de especies por el examen de los aparatos copuladores de las pupas, por lo que encuentro de gran interés divulgarlo, siquiera no pueda augurarse éxito en todos los casos, ya que ello depende del tiempo transcurrido desde que el insecto abandonó el estado de oruga y siguió viviendo. Pero evidentemente muchas determinaciones que no se intentaban sobre las pupas podrán ahora realizarse con toda exactitud.

### ZUSAMMENFASSUNG

Vorliegende Arbeit behandelt die Möglichkeit, Lepidopteren im Puppenstadium zu bestimmen, auf Grund von Genital-Untersuchungen derselben. Wenn diese Methode sich allgemein durchsetzen würde, wäre für die Diagnose der Puppen eine Sicherheit gegeben, die in vielen anderen Fällen zweifelhaft oder unmöglich bliebe. Leider hängt die Ausführung dieser Bestimmung von dem Zeitpunkt ab, an dem die entsprechenden Genital-Charaktere am Studienobjekt im Puppenstadium erkennbar sind, was natürlich bei den einzelnen Arten variiert.

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## SUR LA CONSTITUTION DES BOUCLIERS NOTAUX DES MACHILIDES

Par J. Barlet

Depuis longtemps, les régions pleurales et sternales des segments du corps des Machilides intéressent particulièrement les morphologistes. Les boucliers notaux des mêmes Aptérygotes n'ont quasi pas attiré l'attention<sup>1</sup>.

Ces régions squelettiques certes, à ne les considérer que du dehors chez l'adulte, offrent un aspect fort uniforme. A leur face interne cependant, sont attachés, ainsi que je l'ai déjà fait remarquer en passant (1946, p. 79), des muscles distribués de façon à faire penser à une subdivision des boucliers en deux régions successives principales. Et c'est à cause de l'extension particulière de la plus antérieure de ces régions que le mésonotum offre les dimensions qu'on lui connaît, dimensions ne s'affirmant d'ailleurs au cours du développement, que de façon assez tardive : lorsqu'apparaissent les écailles. Précédemment, j'ai fait allusion à un stade "non encore revêtu d'écailles".

Il convient maintenant que je fasse remarquer que Verhoeff (1911, p. 254) a, en réalité, distingué jadis deux stades sans écailles<sup>2</sup>. Celui auquel j'ai fait allusion — si l'on tient compte de quelques caractères distinctifs notés par l'auteur allemand presque exclusivement dans l'appareil buccal<sup>3</sup> — doit correspondre au premier d'entre eux, le "pseudofötus".

A ce stade précoce, *Dilta hibernica* (Carp.), l'espèce la plus abondante dans notre pays et dont j'ai obtenu jusqu'ici le meilleur matériel, se présente, par l'ensemble de son organisation, comme nettement différente de l'adulte. La forme générale de son corps est plus cylindrique; la tête relativement grosse est prognathe; le pronotum ne s'avance ni latéralement ni dorsalement sur elle; le mésonotum n'est guère proéminent. Les autres tergites ne montrent pas non plus les expansions latérales et postérieure de l'adulte, si bien que presque toutes les membranes intersegmentaires apparaissent au dehors lorsque le jeune insecte se tient étendu sur un substrat. Il est alors bien moins actif<sup>4</sup> qu'aux stades ultérieurs. Son corps est distendu, le tube digestif se trouvant encore encombré de vitellus; il semble aussi que la musculature, notamment la longitudinale, n'est pas prête encore à déployer l'extrême activité qui la caractérisera bientôt.

Les appendices sont également différents : les antennes sont courtes, les pattes sans "styles" coxaux, les cerques très rudimentaires et le cercode est à la fois court et épais.

Le corps, tout à fait dépourvu d'écailles, n'est pas pour cela absolument nu : on le trouve hérissé d'un certain nombre de poils courts baculiformes dont la distribution semble se reproduire avec régularité d'un segment à l'autre.

Au stade suivant le jeune a déjà assez bien changé d'aspect en raison d'une certaine inclinaison de la tête, de l'accroissement de la convexité du mésonotum et d'une expansion postérieure des boucliers notaux. L'insecte fait un peu déjà figure d'adulte. Le corps, toujours sans écailles, est revêtu maintenant d'une toison, mais plutôt clairsemée, de poils fins.

<sup>1</sup> Argilas (1939) s'est occupé du mode d'implantation des écailles sur les tergites thoraciques.

<sup>2</sup> Et lui seul, semble-t-il, Heymons (1906) ayant simplement signalé l'absence d'écailles chez le jeune Machilide à l'éclosion.

<sup>3</sup> Je retrouve chez le jeune *Dilta hibernica* (Carp.) dont il est ici question la même organisation des pièces buccales que celle figurée par Verhoeff (loc. cit. fig. 3, p. 255) chez *Machilis salatrix* Fourcroy.

<sup>4</sup> Comme l'avait déjà constaté Verhoeff (loc. cit., p. 255).

Au troisième stade, la silhouette est déjà tout à fait celle de l'adulte. Les "styles coxaux" sont présents, les cerques et le cercode ont, proportionnellement, toute leur longueur et le corps est recouvert de très nombreuses écailles.

Telles sont — grosso modo — les modifications se produisant chez *Dilta hibernica* (Carp.) à partir du plus jeune des stades que j'ai observés.

Toute notre attention se reportera maintenant sur le premier d'entre eux, le "pseudo-fötus" de Verhoeff, dont il s'agira d'examiner de plus près la constitution des boucliers dorsaux, structure particulière dont aucun auteur ne me paraît s'être occupé jusqu'ici, alors que, selon moi, elle ne laisse pas d'offrir un certain intérêt théorique.

Les boucliers notaux du pseudofötus de *Dilta* ne sont pas seulement fort peu étendus par rapport à ce qu'ils deviennent ensuite, mais encore ils sont doubles : chacun d'eux est fait, peut-on dire, d'un hémitergite droit et d'un hémitergite gauche. Et ces régions sont, sur le vivant, d'une teinte brun orangé tandis qu'entre elles règne une ligne médiodorsale claire que l'on peut suivre à partir de l'arrière de la tête jusqu'au septième urotergite inclusivement. C'est le reste probablement d'une "membrana dorsalis" embryonnaire visible encore chez le pseudofötus.

Mais il y a plus. Il faut examiner encore le relief de chaque hémitergite et, à cet égard, ceux du mésothorax sont plus intéressants que les autres. On les trouve très nettement subdivisés chacun, dans le sens longitudinal cette fois, en trois zones que séparent des sillons transversaux au nombre, donc, de deux. Ces sillons, lorsqu'on les suit dans la direction des flancs, apparaissent de plus en plus profonds; vers la ligne médiodorsale, au contraire, on les trouve de plus en plus effacés. Ils isolent presque complètement une partie antérieure du bouclier notal que j'homologue à un "antenotum" : c'est la zone précédant immédiatement cette ligne transversale d'attaches musculaires qui, chez l'adulte, avait frappé mon attention. (1946, p. 79). Distalement, ledit antenotum offre ceci d'intéressant, qu'il se continue directement en un lobe paranotal très individualisé et à marge fort épaisse<sup>5</sup>.

Le second sillon transversal s'étend moins que le premier sur les côtés. Il y est aussi moins profondément marqué. Sa continuation latéralement, s'incurve en sens inverse, c'est-à-dire vers l'avant, tout en se maintenant à distance du paranotum. Ainsi sont isolées, mais incomplètement, deux zones mésonotales de formes un peu différentes mais d'étendues équivalentes.

A ces constatations que l'on peut faire du dehors, ajoutons maintenant celles auxquelles prêtent la face interne du tégument et la musculature. A ce sujet, il sera commode d'examiner des coupes sagittales<sup>6</sup> de pseudofötus (fig. 1); choisissons-les un peu latérales puisque c'est seulement sur les côtés du notum que les sillons transversaux sont fortement marqués. D'autre part, comme plusieurs muscles fournissant d'utiles points de repère sont intersegmentaires, d'autres segments que le mésothorax devront être envisagés en même temps que lui et c'est cela que représente la fig. 1.

Les sillons transversaux du mésonotum y sont extrêmement visibles. A l'antérieur  $\alpha$  correspond, au dedans du corps, une lame endosquelettique verticale EN de laquelle dépendent nombre de muscles longitudinaux dorsaux ou dorsoventraux. Le même assemblage se retrouve au début du segment suivant, le métathorax, de même au début du premier segment abdominal. Les lames, qui sont bien visibles sur la fig. 1, dis-

<sup>5</sup> Les coupes microscopiques montrent qu'il y a là les réserves nécessaires à l'acquisition des paranota de l'adulte.

<sup>6</sup> Je remercie vivement Melle Delloye (Huy) qui a bien voulu confectionner ces coupes à mon intention.

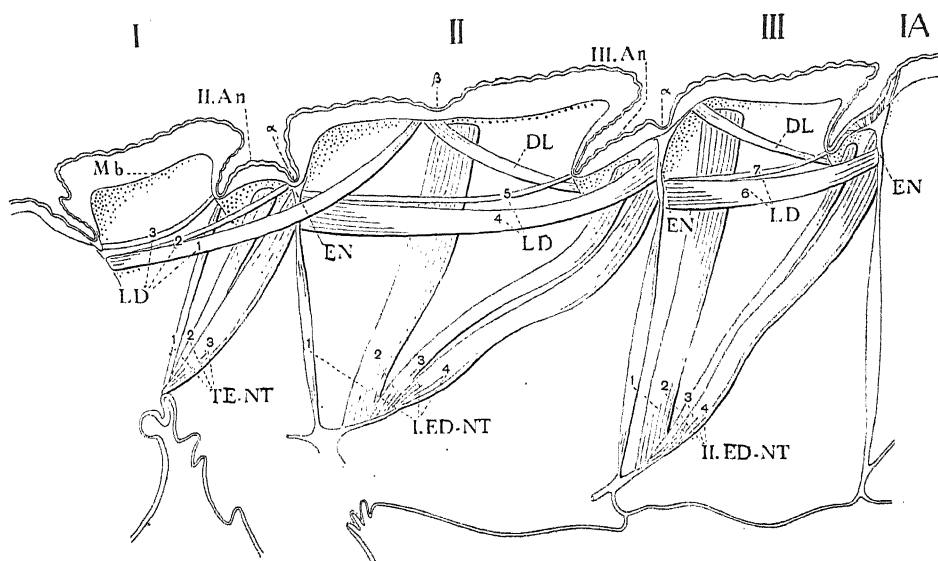


Fig. 1. Moitié droite du thorax pseudofoetal de *Dilta hibernica* (Carp.) Représentation semi-schématique d'une partie de la musculature dépendant des boucliers notaux. Ceux-ci et les sternites ont été sectionnés dans un plan plus externe que le sagittal médian. La tranche figurée combine sept coupes à 7,5  $\mu$ . On voit l'épaisseur de l'hypoderme jeune et la double courbure prise par les muscles I.ED—NTs et à déjà plus longs que leurs homologues métathoraciques en préparation des développements à acquérir ultérieurement surtout par le mésonotum.

I, II, III, IA : pro-, méso- et métanotum, 1<sup>er</sup> uronotum. II An : anténotum mésothoracique —III An : anténotum métathoracique. I ED—NT : muscles reliant l'endosternite prothoracique au notum. II ED—NT : id. au mésothorax.

EN : pièce endonotale (sous-épithéliale).  
 DL : muscles dorsaux latéraux.  
 LD : muscles longitudinaux dorsaux.  
 Mb : membrane basale.  
 TE—NT : muscles tentorio-notaux.  
 α : sillon antérieur du mésonotum ou du métanotum.  
 β : sillon postérieur du mésonotum.

paraîtraient bientôt si l'on se rapprochait de la coupe sagittale médiane. Leur forme, leur emplacement et leurs rapports avec les muscles portent à les considérer comme les homologues des phragmas des Trétygotes. Pourtant, comme les endosternites des Thysanoures et des Collembes (Carpentier, 1946, pp. 171—172; 1947, p. 301), ces lames ne se continuent pas avec la cuticule mais seulement avec la membrane basale Mb de l'hypoderme, lequel, ainsi que le montre la fig. 1, est particulièrement épais chez le pseudofoetus.

A mi-longueur environ du mésonotum, sur la fig. 1, se voit le sillon β. Il est beaucoup moins accusé que le précédent et aucune lame endonotale n'y correspond intérieurement : à peine y remarque-t-on un faible épaissement de la membrane basale, là où s'attachent postérieurement le muscle LD<sub>1</sub> et antérieurement le muscle DL; aussitôt après cette dernière attache se voit celle du muscle endosterno-notal I. ED—NT<sub>2</sub>.

Au métanotum, si l'on voit un faible sillon antérieur  $\alpha$ , on cherche en vain à retrouver un sillon  $\beta$  : la place où il pourrait être, s'il existait, n'est cependant pas difficile à déterminer : elle est très antérieure, les attaches des muscles DL, II. ED-NT<sup>7</sup>, étant là pour en témoigner.

Nous voyons ainsi que la zone antérieure métanotale est fort réduite au profit de la zone postérieure.

Le pronotum est-il partagé comme le sont les autres boucliers dorsaux du thorax? Extérieurement, aucun sillon  $\beta$  n'est visible : à peine un léger affaissement repérable sur certaines coupes seulement. Le sillon antérieur  $\alpha$  pourrait correspondre à la profonde inflexion isolant la tête du prothorax sans qu'à l'intérieur n'existe de formation endonotale caractérisée comme les précédentes. Si l'inflexion est bien telle que je viens de l'interpréter, une partie tout à fait postérieure de la capsule céphalique est à attribuer au prothorax. Un "antenotum" devenu "postnotum" doit être situé là<sup>7</sup>.

Comparons maintenant à la coupe du pseudofœtus celle de l'adulte (fig. 2). Nous y voyons que presque rien n'a été conservé des sillons intratergaux. Un ourlet discontinu (non représenté sur la fig.) de la cuticule externe marque seul l'emplacement du sillon  $\alpha$  au mésothorax. Les formations endonotales ont également régressé, mais en laissant des traces de leur existence chez le pseudofœtus : il en reste quelque chose au métathorax et surtout au premier segment abdominal. D'ailleurs les attaches musculaires encore permettent de s'y retrouver : elles sont assez suggestives pour que, bien

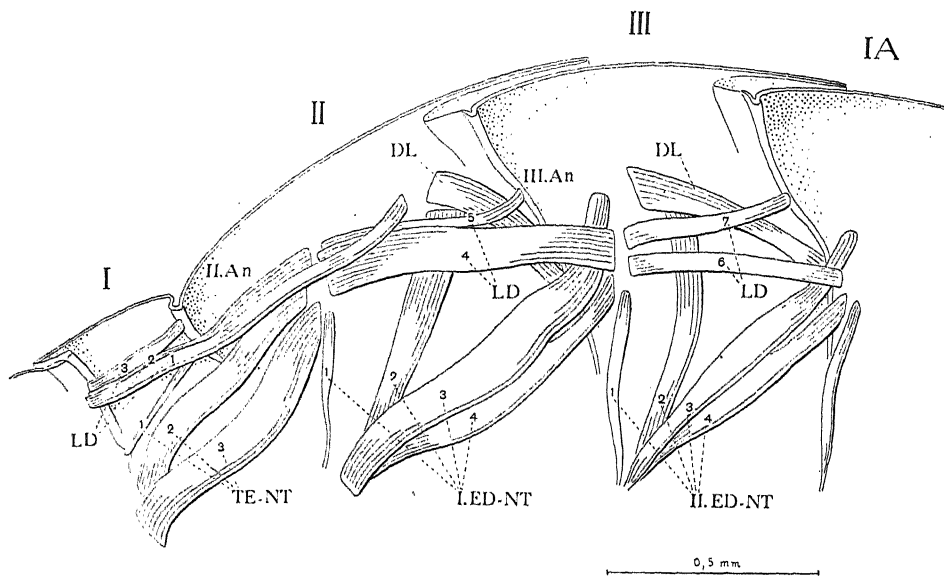


Fig. 2. Moitié droite du thorax de *Dilta hibernica* (Carp.) adulte. Reproduction des mêmes muscles que chez le jeune de la fig. 1.

Les muscles figurés ont été dessinés d'après des dissections ; ils occupent des plans totalisant une épaisseur de 345  $\mu$  environ. La couche d'hypoderme devenue très mince, n'est pas représentée. Aucune formation endosquelettique n'est figurée.

Abréviations comme pour la fig. 1.

<sup>7</sup> Denis (1928) a exprimé à plusieurs reprises l'opinion qu'une partie du pronotum est incluse dans l'arrière de la capsule céphalique des Collemboles.

avant d'étudier mon plus jeune stade, j'ai été frappé, comme je l'ai rappelé plus haut, par la position de certaines d'entre elles.

Mais après cela il était intéressant d'apprendre que les particularités attestées chez l'adulte, presque uniquement par la musculature, influencent également, et à ce point, la cuticule chez le pseudofœtus. Ces particularités, en fait, n'ont rien à voir avec les nécessités mécaniques du saut.

Le Machilide ayant dépassé le stade pseudofœtal saute, comme chacun le sait, avec une grande énergie, mettant alors en action, non pas seulement certains membres locomoteurs mais aussi quasi tous les segments de son corps qui sont extrêmement mobiles. Willem (1924) l'avait déjà bien vu.

L'intérieur du corps est occupé par une musculature spiralée d'agencement fort particulier (Barlet, 1948, p. 78) s'étendant à tout l'abdomen mais dont les premières torsades débutent dans le mésothorax. Dans ce segment également se trouvent les muscles dorso-ventraux les plus puissants du corps<sup>8</sup>. On voit l'importance fonctionnelle du mésotonum, la raison pour laquelle, tout en s'étendant, il s'est unifié, se soudant même au pronotum. On comprend alors que le pseudofœtus, à voûte thoracique plus composite, donc moins résistante, ne puisse pas encore montrer la vivacité dont il deviendra ultérieurement capable.

La complexité du très jeune bouclier mésonotal ne s'explique pas, bien au contraire, par les besoins futurs de l'insecte. Elle ne semble pas non plus en rapport avec les besoins immédiats du pseudofœtus. On peut penser qu'elle ne convient à ce dernier qu'en raison de la vie peu active que lui impose, au reste pour un temps limité, l'état d'inachèvement de son organisme.

Donc ni le futur, ni le présent n'expliquent ce que nous avons observé; nous pouvons dès lors nous tourner vers le passé et voir dans le partage primordial du bouclier notal chez un Aptérygote, que divers auteurs estiment particulièrement archaïque, une sorte de survivance.

Peut-être s'attend-t-on à me voir remettre ici en question, après Handlirsch (1930, pp. 590—592) la thèse de l'aptérisme originel des Aptérygotes. Certes, la construction de la voûte mésothoracique du pseudofœtus ressemble à celle d'un segment ailé. On peut voir dans les deux zones, respectivement antérieure et postérieure au sillon  $\beta$ , les équivalents morphologiques des scutum et scutellum développés par les Ptérygotes. Comme chez ces derniers aussi (Snodgrass, 1927, p. 47), les muscles dorso-ventraux du flanc et de la patte Machilides [dont j'ai antérieurement représenté (1946, fig. 2) un certain nombre] ont leurs attaches groupées sur la zone antérieure, donc "scutale", la "scutellaire" en étant dépourvue.

Mais après cela, il faut bien tenir compte aussi de particularités de la musculature développées dès le pseudofœtus et qui paraissent en contradiction avec une adaptation ancestrale au vol. Il n'est pas à ma connaissance qu'un Ptérygote, voire même une larve de Ptérygote ait été trouvé jusqu'ici muni de muscles intersegmentaires tels que mes LD<sub>1</sub>, ED—NT<sub>3</sub> ou ED—NT<sub>4</sub>. Ces muscles, et d'autres encore, dont il n'a pu être question dans cette note, je ne les ai vus que chez des Aptérygotes de types d'ailleurs fort

<sup>8</sup> Particularité à mettre en relation avec le rôle spécial du mésothorax qu'a observé Willem (loc. cit., pp. 308—310) lorsque l'animal saute.

divers que j'ai étudiés jusqu'à présent<sup>9</sup> (voyez déjà à cet égard les fig. 1—5 de Maki, 1938, qui peuvent fournir d'utiles indications en attendant mieux).

Je ne vois donc pas que mes observations puissent contribuer directement à prouver que les ancêtres de nos Aptérygotes aient jamais pu voler. Mais je leur trouve une autre portée théorique. Elles posent la question de savoir si la construction caractéristique d'un tergum ailé est vraiment aussi totalement qu'on s'accorde, semble-t-il, à le penser depuis bon nombre d'années, le résultat d'une adaptation secondaire au vol; en conséquence de quoi toute tentative d'homologation avec un mode de subdivision observable ailleurs, surtout au pronotum, n'offrirait morphologiquement parlant, aucun intérêt.

De tels rapprochements pourront et devront encore être tentés bien que, certes, avec toute la prudence nécessaire. Le cas des Machilides nous invite opportunément à rechercher si l'histoire ancienne du notum, comme celle des autres constituants du squelette thoracique des insectes ne serait pas, à la vérité, moins simpliste qu'on ne l'imaginerait d'après ce qu'une larve holométabolique cède à une nymphe pour modeler une voûte tergale capable d'aider au vol<sup>10</sup>.

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<sup>9</sup> Il est possible cependant qu'on arrive à démontrer que certains muscles intersegmentaires particulièrement longs des Aptérygotes trouvent un équivalent dans certaines larves holométaboliques sous forme de files de deux ou plusieurs éléments se suivant bout à bout. Mes recherches sur les Aptérygotes m'ont permis de rencontrer des cas précis autorisant une telle hypothèse.

<sup>10</sup> Il est vrai que même la comparaison avec une larve pourrait devenir plus instructive que j'ai l'air de le prétendre ici : voyez, par exemple, la continuation directe d'un antenotum mésothoracique dans le paranotum d'une larve de Calosome (Crampton, 1918, fig. 21), exactement comme chez le pseudofœtus; une particularité que Crampton (loc. cit., p. 55) estimait secondaire par rapport à la simplicité d'un notum de Lépisme.



## ÜBER DIE PLETHOPTERYGIE BEI DEN SCHMETTERLINGEN

Von *Felix Bryke*

Die Zeiten sind vorbei, als man die Monstra allein von der grotesken Seite der Kuriosität betrachtete. Wurde ein Kalb mit zwei Köpfen, ein Füllen mit sechs Beinen geboren, flugs wusste man daraus zu prophezeien: es müsste eine Naturkatastrophe oder ein Krieg oder eine Epidemie eintreten. Allenthalben sammelte man in den Kuriositätenkabinetten diese so genannten *lusus naturae*, oft Artefakte simpelster Natur, oder Marktschreier führten die merkwürdigsten Missgeburten einem neugierigen und ungebildeten Publikum in Schaubuden oder im Panoptikum vor.

Erst zu Beginn des 19. Jahrhunderts begann man das biologische und physiologische Problem der Monstrositäten kausal zu anzugreifen. Der hervorragende deutsche Humorist *Jean Paul* war einer der ersten, der auf die grosse Bedeutung hinwies, die die Monstrositäten für das Verständnis des Werdeganges eines Bildungsprozesses haben. Es genügt einen Satz von ihm anzuführen: „Alles Leben, auch nur eine Minute, hat ewige Gesetze hinter sich, und ein Monstrum ist bloss ein Gesetzbuch mehrerer Staatskörperchen auf einmal; auch die unregelmässigste Gestalt bildete sich nach den regelmässigsten Gesetzen.“ Man fahndete somit — um mit *Friedrich von Schiller* zu sprechen — nach dem Gesetze der Gesetzlosigkeit.

Als viel später der Heidelberger Anatom *Schwalbe* alle menschlichen Monstra in ein System zusammenfasste, war die Bahn für allerlei Spezialuntersuchungen frei. In diesem Zusammenhange kann ich nicht umhin zu erwähnen, dass ein bekannter Arzt es sogar versuchte, einige aus der *teratologia humana* gewonnene Befunde rationalistisch zur Deutung der mythischen Sagegestalten aus dem alten Hellas auszulegen. So würde man z. B. den Göttervater Saturnus, der dem Mythos nach seine Kinder auffrass, auf einen Epignathus zurückführen können, eine Missgeburt, bei der der Autosit in seinem Munde den Kopf des Parasiten, den ich richtiger *Episit* nennen möchte, trägt. Auf ähnliche Weise liesse sich die Entstehung des Janus mit zwei Köpfen oder sogar des Polyphem mit einem Auge u. s. w. deuten. Ja, sogar für den phantastischen Kentaur mit seinen sechs Extremitäten — mit vier Pferdebeinen und zwei menschlichen Armen — würde ein Monstrum eines sechsbeinigen Pferdes Modell gestanden haben.

So weit ist man indessen in der Entomologie noch nicht gekommen, dass man alle Arten teratologischer Bildungen bei den Insekten systematisch zusammengefasst hätte. Die zwei, drei existierenden zusammenfassenden Werke über dieses Thema kennen jedenfalls die pathologischen Bildungen nicht, die ich für den heutigen Vortrag gewählt habe. Man erwähnte überzählige Antennen oder Beine, oder deren Displazierung bei Käfern, Bienen oder Schmetterlingen, oder wie *Goldschmidt* bei seinen Intersexen fand, Plusbildungen von Valven an der männlichen Sexualarmatur bei Schmetterlingen u. s. w. Ja, man hat gerade bezüglich der Zwillingsbildungen ein Gesetz, die *Bateson'schen* Regeln, erkannt, auf das ich noch zurückkommen werde, aber die *Plethopterygie*, wie ich das Phänomen der überzähligen Schmetterlingsflügel nennen möchte, mit ihrem abgeleiteten Spezialfalle, nämlich der Bildung in der Art von siamesischen Zwillingen von zusammengewachsenen Zwillingsflügeln, was ich *Didymosis* benannt habe, wurde ganz stiefmütterlich behandelt. Erst in den letzten Dezennien haben *Krulikowsky*, *Christeller*, *Hencke*, *Hering* und ich die Kasuistik des Vorkommens von

Plethopterygie um einige weitere Fälle bereichert, die sich an den Fingern abzählen lassen.

Mein summarisch abgefasster Vortrag hat zum Thema das merkwürdige Phänomen des Auftretens von sogar sechs Flügeln bei einem Individuum. Ja, gibt es denn wirklich Insekten mit sechs Flügeln? Diese Frage richtete an mich einmal ein namhafter Koleopterologe. O ja! Ich meine nicht jene kleine Gruppe von Geometriden, die Warren in eine natürliche Gruppe der Trichopterygiden zusammenfasste (nicht zu verwechseln mit der Käferfamilie *Trichopterygi(!)dae*, jetzt *Ptiliidae*). Freilich besitzen die Vertreter der Gattungen *Acasis*, *Episauris*, *Lobophora*, *Oulobophora*, *Nothopteryx*, *Myristicoptera*, *Trichopterygia* u. a. ausser den obligaten vier Flügeln noch je einen zipfelartigen Lappen hinter jedem Hinterflügel, aber bei näherer Untersuchung erweist sich dieser lappenartige Anhang als ein Teil des normalen Hinterflügels: es lassen sich oft in den Rippen des Lappens die zum verkürzten Hinterflügel gehörenden Dorsalrippen erkennen. Übrigens treten diese „überschüssigen“ Hinterflügel nur beim ♂ auf, sie sind als sekundäres Geschlechtsmerkmal zu werten. Bei der Gattung *Spata* ist der Flügellappen sogar zu einer Tasche umgebildet. Es gab aber einst Insekten mit sechs Flügeln. Die von den Paläoentomologen beschriebenen *Dictyoneuridae* besaßen ausser den homophoren vier Flügeln am Prothorax ein Paar flügelartige Seitenlappen, die allmählich rückgebildet wurden, bis sie verschwanden. Bei den Schmetterlingen findet man freilich ein Organ, die Patagia, auf dem ersten Thorakalsegment, das mit dem umgebildeten erwähnten ersten Flügellappenpaare homologisiert wurde, aber es zeigte sich, dass man das heilige Gesetz der Homologie umgangen hatte: die Patagia ist nicht an jener Stelle lokalisiert, an der das erste Paar der Flügelreste sass.

Die Plethopterygie wurde meines Wissens bisher nur bei den Schmetterlingen festgestellt. Die zwei überschüssigen Flügel, die man bei diesen Monstrositäten findet, bedeuten auch keinen atavistischen Rückschlag. Sonst müssten sie auf dem ersten Thorakalsegmente inserieren, was nicht beobachtet wurde. Anstatt dessen findet man sie einzig auf dem Meso- oder Metathorax, je nachdem sie vor und an dem Vorderflügel oder Hinterflügel angebracht sind. Die überzähligen Flügel treten, nach den bisherigen Funden zu urteilen, nie symmetrisch auf beiden Seiten des Thorax auf. Die episitären Flügel folgen dabei stets den Batesonschen Regeln, d. h. der an den autositären Flügel angrenzende erste überzählige Flügel ist spiegelbildlich zu einer gemeinsamen Achse orientiert. Sein Nachbarflügel nimmt zum letztgenannten wieder die gleiche Lage ein, wie der oberste zum autositären Flügel: also wieder wie ein Spiegelbild. (Sehr anschaulich bei H e n c k e s *Aglia tau* festzustellen). Diese plethopterygen Extremitäten müssen nicht durchaus getrennt vorkommen, sondern sie können als eine Variante von Plethopterygie in der von mir benannten Didymosis auftreten: der episitäre Flügel wächst mit dem autositären zusammen und bildet einen einzigen vergrösserten und deformierten Flügel — also eine siamesische Zwillingbildung. Es tritt auch eine Kombination von beiden Formen von Plethopterygie auf, wenn der überschüssige Flügel gleichzeitig didymotisch ist, wie bei meiner *Perisomena caecigena* (Kup.). Kasuistisch tritt die echte Plethopterygie und Dydimosios auf Vorder- (= *Didymosis anterior*) und Hinterflügeln (= *D. posterior*) auf. Es vermag sich indessen auch, wie im Falle von Herings *Papilo machaon*, zwischen den Rippen  $m_1$  und  $m_2$  des Vfgls. der Zwilling einzuschieben.

Ich will Sie hier nicht mit trockenen Analysen jedes einzelnen Fundes langweilen, möchte nur auf die Wichtigkeit der Zeichnung für die Rippenidentifizierung aufmerksam machen, um die Zusammensetzung des didymotischen Flügels richtig topisch deuten

zu können. Und dabei erweist es sich, welch grosse Bedeutung den Zeichnungselementen zukommt, da schon ein einzelner kleiner Fleck, der normal an eine ganz bestimmte Rippe gebunden ist, als Indikator bei der Analyse eines schwer deutbaren teratologischen Falles dienen kann. Die Entstehung der Didymose erkläre ich mir durch embryonale oder postembryonale Teilung der Keimscheiben.

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## STRUCTURE MORPHOLOGIQUE DE LABIUM DIPTÉROÏDE; SON ÉVOLUTION

Par François Gowin

Le labium diptéroïde primitif, tel que nous le trouvons réalisé chez les Nématocères inférieurs (cf. I m m s) se compose du submentum (Sm), du prémentum (Pm) et d'un labellum formé de deux articles pairs (Lab I, Lab II), munis chacun d'un sclérite. La musculature de cet ensemble est, par rapport au schéma orthoptéroïde, restreinte à l'essentiel et légèrement transposée. Le submentum ne présente plus d'insertions et d'origines musculaires et tend lui-même à disparaître en tant que sclérite. Le prémentum est largement pourvu de muscles : il y a d'abord un muscle craniopréméntal rétracteur (M Pm) qui, toujours présent, ne varie pas (nous n'y reviendrons plus). Le prémentum (theca des auteurs anglo-saxons) offre en plus les origines des trois muscles suivants : d'arrière en avant : le muscle "oblique" (M Lab 1a) dirigé ventro-dorsalement et d'arrière vers l'avant, et deux muscles longitudinaux ventraux s'insérant sur les sclérites labellaires : le M Lab 1 et le M Lab 2, ce dernier maintenant toujours ses connexions et sa position. (fig. 1, Dipt).

Le labium est primitivement un organe mou et épais; le côté interne (dorsal) est en gouttière (PLb) dont le fond est sclérifié et qui forme glissière pour les stylets de la trompe : maxille, éventuellement mandibule, hypopharynx; cette gouttière labiale est coiffée par le labro-épipharynx.

Comment interpréter cette structure? Morphologiquement deux hypothèses sont plausibles. La première homologue les labelles aux glosses resp. paraglosses du schéma orthoptéroïde. La disposition musculaire en effet suggère cette interprétation : le muscle M Lab 1 étant le muscle glossal, le M Lab 2, le muscle paraglossal : mais cette interprétation fait disparaître les palpes et leur musculature. La seconde hypothèse, classique celle-là, homologue les labelles au premier et au deuxième article des palpes : mais cette hypothèse, supposant la disparition de l'un des deux muscles du premier article du palpe, annule l'antagonisme fondamental du système musculaire de cet article. Par contre, l'existence du mutant *proboscipedia* de *Drosophila melanogaster* (chez lequel les labelles sont transformés en organes ressemblant à un tarse) est en faveur de cette hypothèse classique. (Bridges et Dobzhansky).

La constitution primitive du labium ne varie guère chez les Nématocères. Mais il n'en est plus de même chez les Brachycères.

Chez le Taon, en effet il se fait une première transformation : les premiers labelles (Lab I) font corps avec la partie basale du labium et seuls les deuxièmes labelles (Lab II) restent individualisés et forment cet organe en coussinet communément désigné par ce terme et comportant le réseau pseudotrachéen (fig. 1, Tab). Cette interprétation nous est suggérée par la disposition de la musculature. Pour nous, toute la partie intermédiaire entre la racine du deuxième labelle et l'extrémité antérieure du prémentum d'une part et à l'aire d'insertion du muscle "oblique" d'autre part représente le premier article du labellum. C'est d'ailleurs cette partie qui évoluera et transformera les parties avoisinantes du labium, les labelles II restant en dehors de ce mouvement évolutif, quelques modifications "adaptatives" mises à part, son muscle en particulier, comme d'ailleurs aussi le muscle craniopréméntal (M Pm) rétracteur, maintiendra sa position longitudinale ventrale.

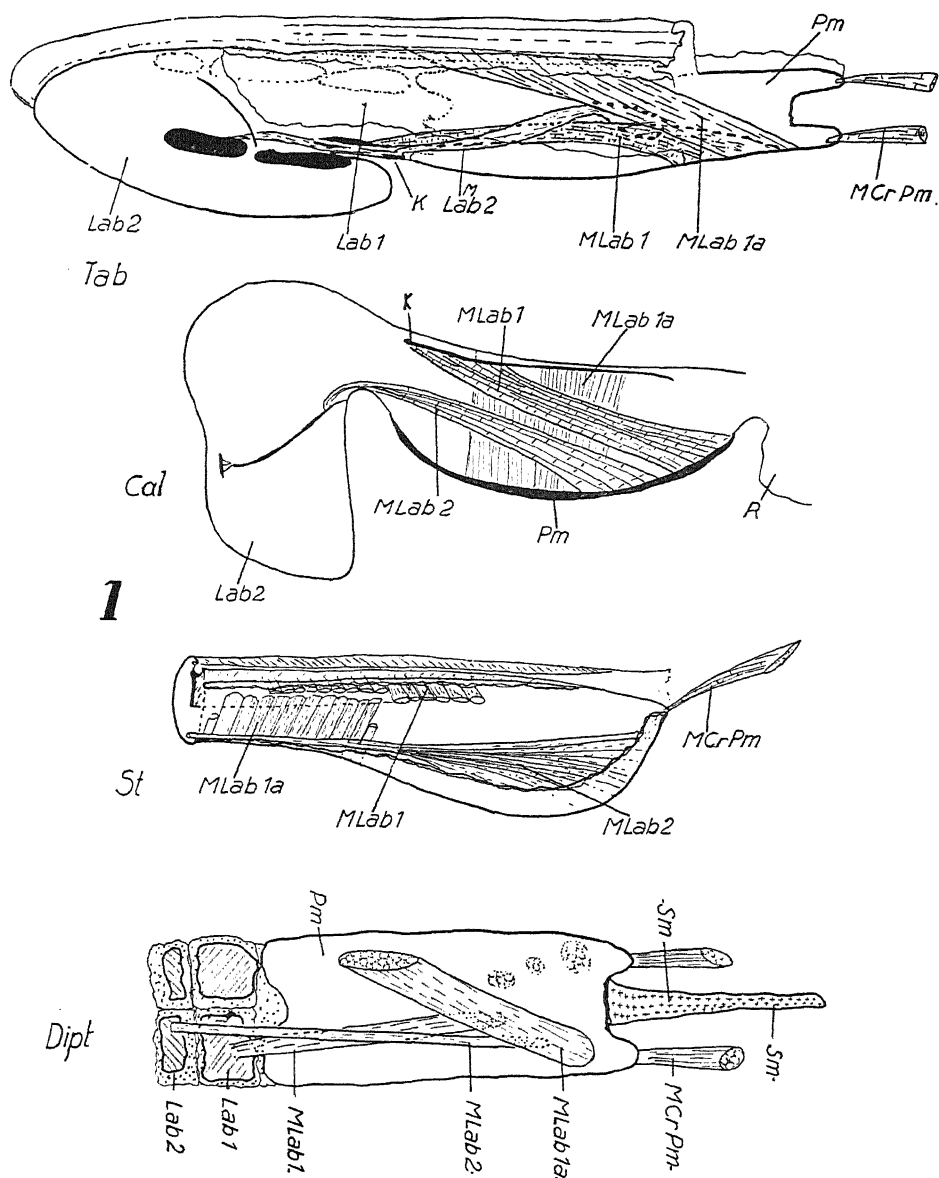


Fig. 1. Schéma généralisé du labium diptéroïde (Dipt.) et diagrammes longitudinaux du labium de *Tabanus* (Tab), de *Calliphora* (Cal, d'après Graham-Smith) et de *Stomoxys*. cf. fig. 2.

Pm, prémentum; M Cr Pm, muscle cranio-prémental rétracteur; M Lab 1 a muscle "oblique"; M Lab 1, muscle du premier article du labellum; M Lab 2, muscle du deuxième article du labellum; K, sclérite dit "K" du premier article du labellum (ou paraphyse); Lab 1, Lab 2 premier et deuxième articles du labellum. — R, extrémité du rostre. — Sm, submentum.

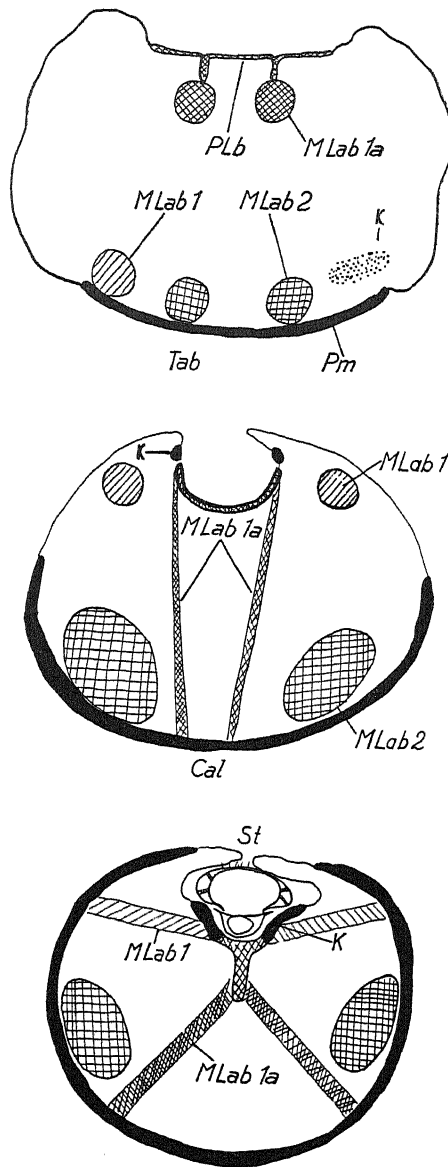


Fig. 2. Coupes transversales schématisées du labium de *Tabanus*, de *Calliphora* (d'après Graham-Smith) et de *Stomoxys* (celui-ci montrant le labroépipharynx et l'hypopharynx). PLB, plancher de la gouttière labiale; les autres notations comme dans la fig. 1.

Les connexions reconstruites chez *Tabanus*, se retrouvent chez *Eristalomyia*, de même que la labium conserve ses fonctions de glissière. *Eristalomyia* peut être considéré comme le point de départ de l'évolution chez les Cyclorrhaphes. Cette évolution se fait suivant deux modalités et aboutit soit aux types lécheurs, soit aux types piqueurs (*Stomoxys*, *Glossina*, *Pupipara*). Elle consiste essentiellement dans des remaniements architecturaux des divers éléments.

C'est ainsi que chez les Acalyptrates et chez les Calyptrates lécheurs (*Musca*, *Calliphora*) ce sclérite "K" (du premier article labellaire) prend une position dorsale et devient, chez *Calliphora*, la parapyse (fig. 1, 2, Cal, d'après G r a h a m - S m i t h); le muscle correspondant prend donc une direction oblique. Au contraire, le muscle primitivement oblique (M Lab 1a) se met en position nettement dorso-ventrale et le prémentum devient plus enveloppant.

Ces translation s'accroissent chez les piqueurs (Fig. 1, 2, st) (*Stomoxys*, *Glossina*, *Pupipara*) chez lesquels tout le labium, extérieurement, semble être d'une seule pièce, entièrement sclérifiée. Le prémentum est devenu très enveloppant, le sclérite "K" s'est considérablement étiré et, devenu interne, forme le plancher de la gouttière labiale presque fermée, tandis que le sclérite primitif de cette gouttière se transpose suivant une crête sagittale interne. La musculature a suivi cette évolution : c'est ainsi que le M Lab I (de "K") est dissocié en de nombreux faisceaux parallèles (étirement en longueur du sclérite d'insertion) et il a une direction presque perpendiculaire au grand axe (translation vers la base labiale des aires d'insertion). Le muscle M Lab 1a (oblique chez le Taon et transversal chez *Calliphora*) est, chez *Stomoxys*, oblique, mais en direction inverse : c'est-à-dire que son aire d'insertion est ramenée vers la base labiale et elle se trouve sur la crête sagittale. Pour compléter cette architecture, les labelles II sont entièrement cornées et petits et garnis d'épines et de lamelles tranchantes perforatrices de la peau.

C'est ainsi qu'un organe mou et épais chez le Taon et ne servant que de glissière aux stylets perforants de la trompe, se transforme, par translation dorsoventrale et longitudinale de ses maxilles qui, ayant évolué de leur côté, sont devenu un levier d'érection. Ce labium des Cyclorrhaphes piqueurs donne à ce groupe une position tout à fait particulière parmi les Insectes.

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L'APPAREIL BUCCAL DE *Tipula* sp.

Par François Gouin

Quelques remarques faites par H. Weber (1933, fig. 95) et par Heddergott au sujet des Tipulides sont à l'origine d'une étude de l'appareil buccal de *Tipula* sp., brièvement résumée dans cette communication.

La tête de ces diptères nématocères est formée de deux parties nettement tranchées : une capsule à peu près sphérique et un rostre fort allongé (fig. 1), à l'avant duquel

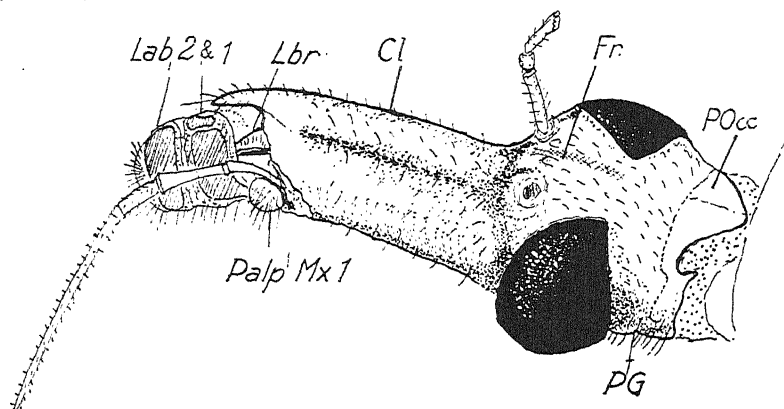


Fig. 1. Vue extérieure de la tête. — Lab 2 & 1, deuxième et premier article du labellum, LBR, labrum; Cl, clypeus; Fr, front, POcc, postocciput; PG, postgenae; Palp Mx 1, premier article du palpe maxillaire.

apparaissent les palpes maxillaires et les deux articles du labellum soutenus chacun par un sclérite. La capsule est formée dorsalement par un étroite zone frontale (hachurée sur la fig. 1) puis le vertex et l'occiput et le postocciput; latéralement, autour des yeux, par les genae et les postgenae; ventralement par une sorte de gula. Le rostre, au contraire, est formé par le clypeus très étiré qui a proliféré sur les côtés jusqu'à la ligne ventrale, rejetant vers l'intérieur tous les éléments ventraux et en particulier le labium et les maxilles (fig. 3).

Quant à l'appareil buccal, il est profondément modifié; les mandibules sont absentes.

Les maxilles sont représentées par un sclérite en forme de T, dont seule la branche transverse est visible à l'avant du rostre à la base des labelles (fig. 2 A); leur situation, bien qu'interne, est néanmoins superficielle (fig. 2 A). De part et d'autre de la branche transverse s'insèrent les palpes, dont le premier article globuleux est faussement désigné par "stipes" par les auteurs cités. Ce sclérite en T porte les insertions de deux muscles et les origines de deux autres, pairs, (fig. 2 A). Les deux premiers sont les muscles propres de la maxille et ont des origines craniennes, situées l'une à côté de l'autre à la base du rostre. L'un de ces muscles s'insère à l'extrémité postérieure de la tige, l'autre sur la branche transverse. Le deuxième groupe comprend les muscles du premier article palpaire (fig. 2 A); les origines se trouvent sur la tige, soit à l'extrémité postérieure, mais en avant du muscle crânien précédent; soit près de l'insertion de la branche transverse. Ces dispositions autorisent l'interprétation suivante par référence au schéma



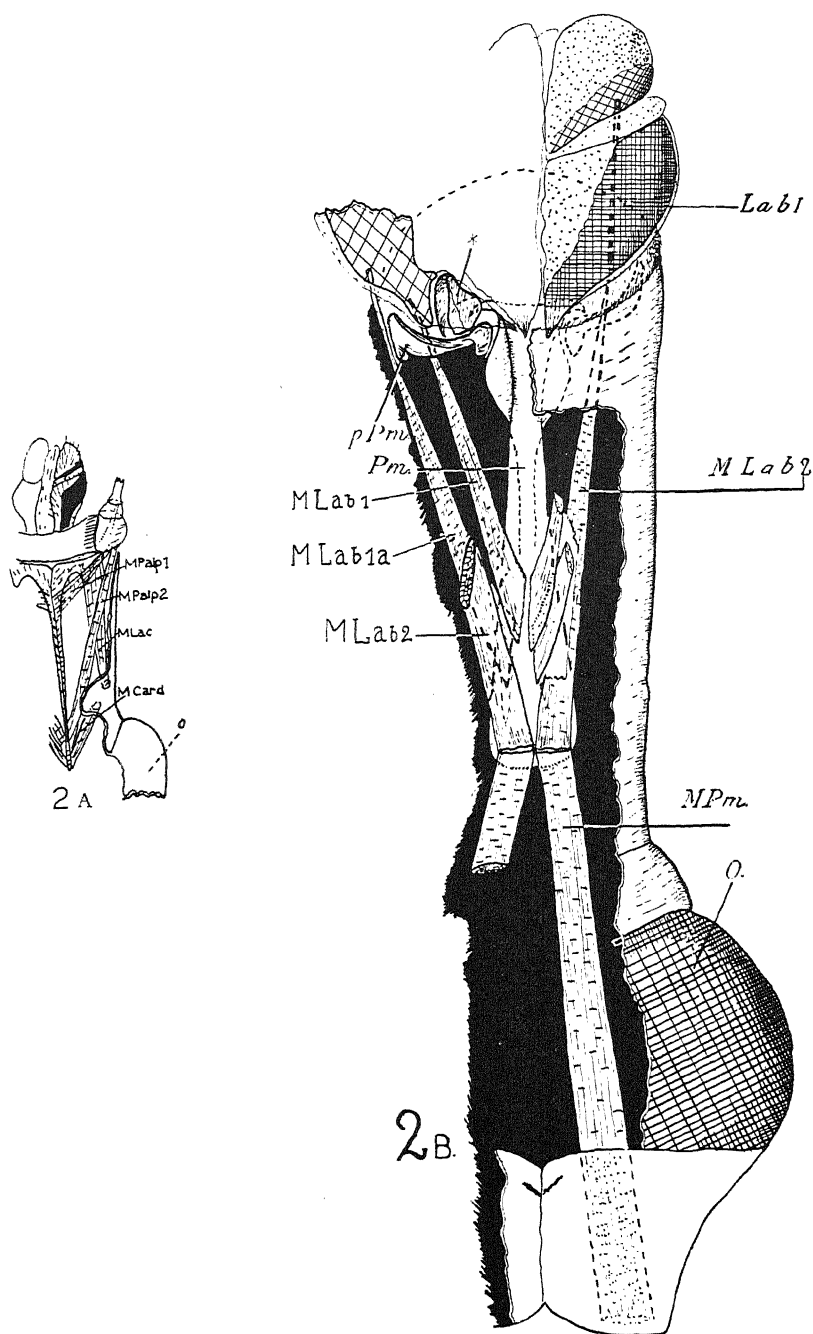


Fig. 2. A, appareil maxillaire; — B, Labium. — M Palp 1, M Palp 2, M Lac, M Card: musculature des articles du palpe maxillaire, de la lacinia et du cardo. O, oeil; Lab 1, sclérite du premier article du labellum; Pm, prémentum; M Lab 1 a, M Lab 1 a, M Lab 2, M Pm: musculature du premier et du deuxième article du labellum et du prémentum.

“orthoptéroïde” : la tige du sclérite en T représente les stipites et les cardines droits et gauches soudés, car elle porte — comme dans le schéma orthoptéroïde — les origines des muscles palpaire d’une part et d’autre l’insertion d’un muscle crânien, le muscle cranio-cardinal. La branche transverse est homologue des laciniae, car, comme dans le schéma orthoptéroïde, elle a un muscle crânien.

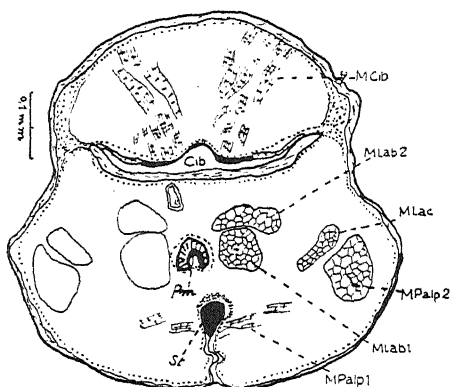


Fig. 3. Coupe transversale du rostre passant près de l'extrémité antérieure. — Cib. Cibarium; M Cib, muscles dilateurs du cibarium; St, stipes. Le reste comme aux deux fig. 1 et 2.

Le labium se présente sous la forme d'une tige située à peu près dans l'axe du rostre. Elle est, à l'arrière, spatulée, carénée dans sa partie médiane et, à l'avant, élargie; elle s'articule aux sclérites des articles basaux du labellum par l'intermédiaire de deux petits pièces sclérifiées (Fig. 2 B). Quatre muscles sont en rapport avec ce sclérite : trois d'entre eux s'insèrent sur les sclérites labellaires I & II et ont leurs origines sur la partie en spatule du labium (M Lab 1, M Lab 1a, M Lab 2), l'autre a son origine au fond de la capsule crânienne et s'insère sur le labium en connexions étroites avec les muscles précédents (M Pm). Le sclérite axial est donc, nous semble-t-il, le prémentum et les muscles sont les muscles du premier et du deuxième article des palpes labiaux et le muscle cranio-prémental, rétracteur.

D'autres types de *Tipuloidea* (*Pedicia*) sont beaucoup moins évolués; en particulier le rostre est plus court, le clypéus est moins envahissant, les éléments maxillaires superficiels et indépendants, sauf dans leurs parties basales (stipites p.p., cardines) où ils sont soudés. Le prémentum est réduit à deux sclérites antérieurs.

Modifiant les opinions de H. Weber et de Heddergott, nous affirmons que les *Tipuloidea* se sont détachés très tôt du phylum des Nématocères et ont suivi une évolution parallèle à celle des *Mecoptera* et dont *Tipula* est le terme.

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## LA MAXILLE ET SON ÉVOLUTION CHEZ LES DIPTÈRES BRACHYCÈRES

Par François Gouin

En position ventrale primitive et en rapport avec le tentorium, la maxille est, chez le Taon, formé des trois éléments fondamentaux : cardo, stipes, un lobe, qui est, comme I m s l'a démontré, la lacinia. La musculature comporte en plus des muscles palpaire un muscle cranio (géo-) cardinal, un muscle tentorio-stipital et un muscle craniolacinial. Elle a chez le Taon une fonction proprement gnathale et elle contribue, grâce à l'ornementation en crochets et épines diverses de la lacinia, à dilacérer les tissus (tandis que la mandibule les tranche). (cf. Gouin, 1948 b).

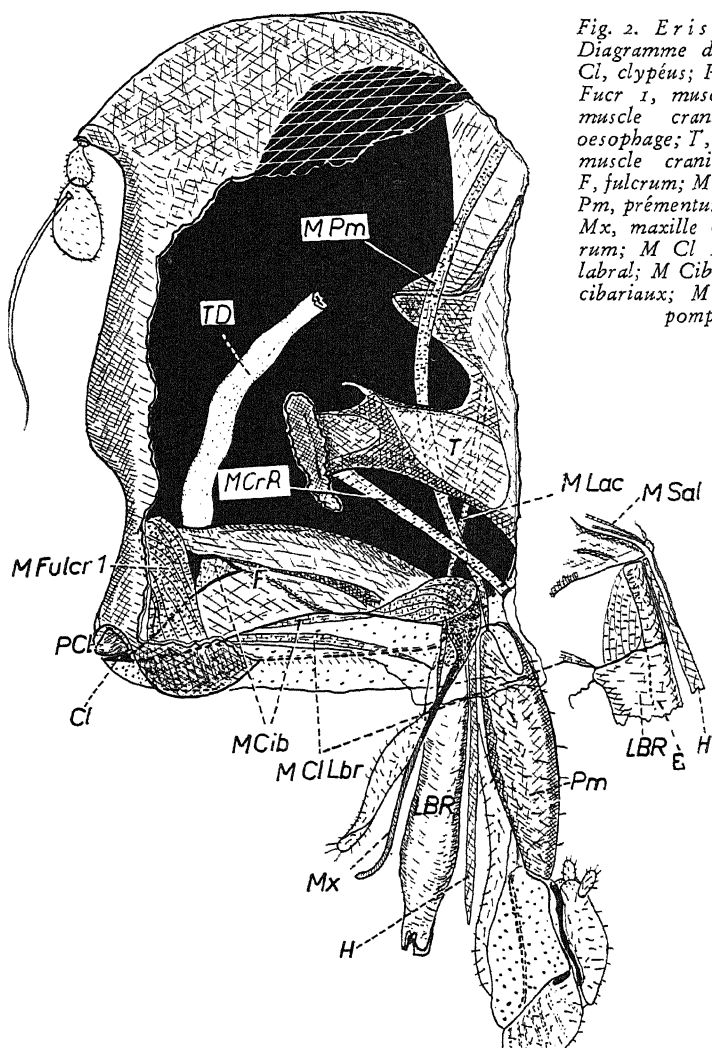


Fig. 2. *Eristalomyia* sp. — Diagramme de l'appareil buccal. Cl, clypéus; PCL, postclypéus; M Fulcr 1, muscle fulcral; M Pm, muscle cranio-prémental; TD, oesophage; T, tentorium; M Cr R, muscle cranio-rostral (cardinal; F, fulcrum; M Lac, muscle lacinial; Pm, prémentum; H, hypopharynx; Mx, maxille (lacinia); LBR, labrum; M Cl Lbr, muscle clypéo-labral; M Cib, muscles dilateurs cibariaux; M Sal, muscle de la pompe salivaire.

Ces connexions avec le tentorium sont rompues chez le *Bombylius*, type orthorrhaphe à rostre mobile, chez lequel le corps maxillaire est interne; le cardo garde son muscle génal, tandis que le muscle stipital reporte son origine sur le fulcrum. Mais, chez les Orthorrhaphes, cette évolution s'arrête là.

Elle reprend sur une autre voie chez les Cyclorrhaphes : la maxille migre vers la région dorsale en même temps qu'elle se réduit à une sorte de baguette appelée apodème. Cette évolution se fait en plusieurs étapes et parallèlement à celle du clypéo-cibarium retracée d'autre part. (Gouin, 1948 b).

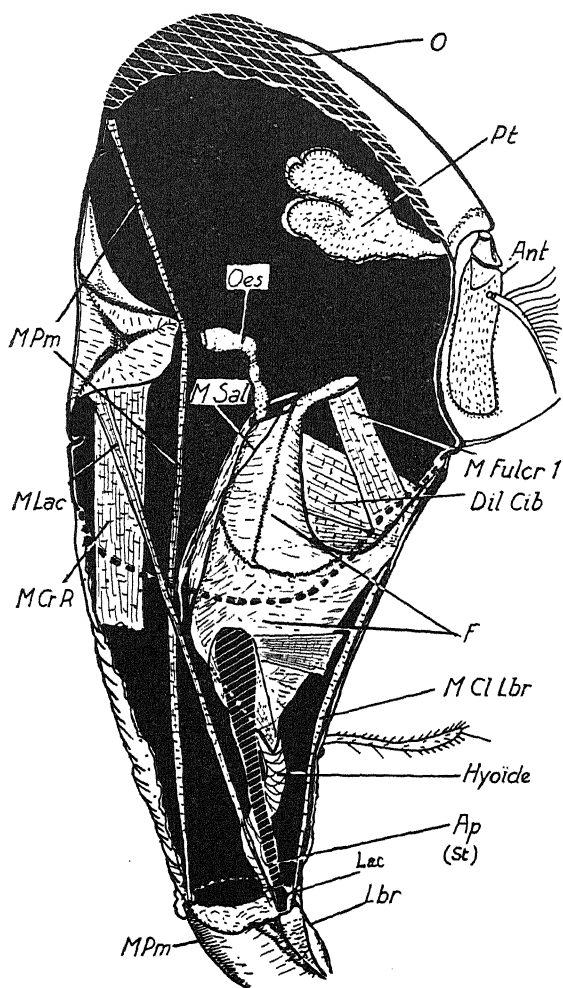


Fig. 3. *Stomoxys calcitrans* — Diagramme de l'appareil buccal. — o, oeil; Pt, ptilinum.

Chez *Eristalomyia* (fig. 2), qui en constitue le point de départ, un repère précieux nous est donné par le tentorium. A côté de l'invagination antérieure se trouve l'origine d'un muscle qui, d'autre part, s'insère sur un petit sclérite à la base de la membrane rostrale ventrale, près de l'invagination tentoriale postérieure. A notre sens, cet ensemble représente le cardo et son muscle : il a donc conservé sa position ventrale primitive ainsi que ses connexions. Le reste de la maxille est situé plus dorsalement et le lobe est en dehors du canal alimentaire de la trompe. Le stipes est intérieur : il a les mêmes connexions que celui du Bombyle, c'est-à-dire que le muscle stipital (dont l'origine était primitivement tentoriale) a ses attaches sur le fulcrum et il a augmenté en puissance. A l'endroit, où le stipes perce la membrane rostrale, sont insérés d'une part les palpes et d'autre part le fin muscle cranio-lacinial. La lacinia est la seule partie externe, et elle est encore en rapport avec les palpes.

Ces connexions ne changent guère chez les Conopides et les Acalyptatés; seule la lacinia subit quelques modifications quant à ses dimensions et sa forme; elle est toujours réduite à un appendice baculiforme ou foliacé, mais, bien que sa situation soit plus dorsale que celle de la maxille d'*Eristalomyia*, elle reste toujours indépendante du labrum.

Il n'en est plus de même chez les Calyptatés lécheurs et piqueurs et les Pupipares. Chez ces formes, le stipes (apodème) entièrement interne a perdu le contact avec les palpes insérés sur la membrane rostrale (chez *Stomoxys*, il reste lié à ceux-ci par un mince ligament sclérifié), la lacinia est réduite à un très court sclérite superficiel (fig. 3) articulé sur le labrum. Le muscle lacinial s'insère à l'endroit précis où l'apodème perce la membrane rostrale. Le muscle fulcro-apodémal (stipital) se divise en deux faisceaux (Calyptatés) ou bien en trois faisceaux (Pupipares). Cette maxille des Calyptatés est une sorte de baguette d'une venue, fortement sclérifiée; les coupes transversales montrent, au centre, un axe chitineux entouré d'un épithélium, ce qui indique bien que l'apodème est invaginé par suite, nous semble-t-il, d'une croissance exagérée de la membrane rostrale.

Au terme de son évolution, la maxille a donc complètement perdu sa fonction propre d'appendice gnathal et est devenue un levier d'érection de la trompe, joignant son action à celle du muscle prémental et labral. Cette évolution est parallèle à celle du domaine clypéo-cibarial et du labium, que nous retraçons d'autre part (Gouin, 1948 b, 1948 d).

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## ÉVOLUTION DE LA RÉGION CLYPÉO-CIBARIALE CHEZ LES DIPTÈRES BRACHYCÈRES

Par François Gouin

La région clypéo-cibariale de la tête — chez les insectes en général — est selon Snodgrass définie d'une part par la région de la face délimitée par les invaginations tentoriales antérieures, la suture épistomale et le labrum, d'autre part le cibarium ou portion de l'atrium prébuccal située immédiatement en avant de la bouche, celle-ci étant le lieu "géométrique" où le tractus digestif se forme en un tube.

Chez *Tabanus*, qui est comme le point "nodal" des Brachycères, le clypéus et le cibarium, bien qu'ils se correspondent, n'ont entre eux que des liens très lâches. Le clypéus est un territoire de la face, immobile, solidaire de la capsule céphalique et plus ou moins homogène, tout au plus deux sillons longitudinaux y différencient-ils une zone centrale, le centroclypéus. (fig. 1, Cl). A l'intérieur de la tête lui correspond le "cibarium" qui se présente ici sous la forme d'une gouttière à double fond formée des prolongements de l'épipharynx et de l'hypopharynx; cet organe est prolongé par deux courtes apophyses entre lesquelles se trouve la pompe pharyngienne antérieure. (fig. 1, F, Ph.). La musculature comporte les habituels dilataateurs cibariaux (Dil Cib)

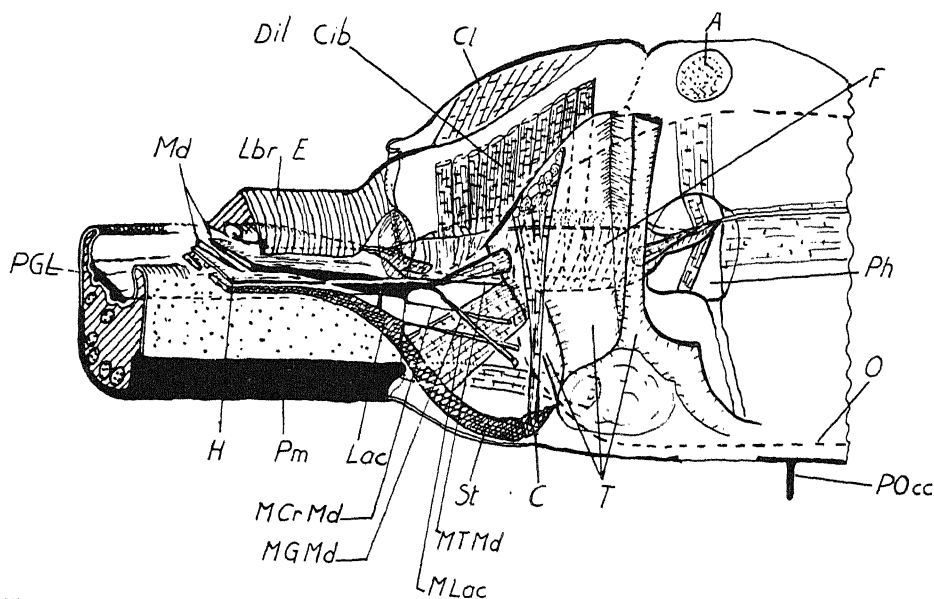


Fig. 1. *Tabanus bovinus* q. Diagramme de l'appareil buccal. Comparez avec les figures 2 et 3 (Gouin, 1948 c, d, p. 551, 552). Md, mandibules; LBR E, labro-épipharynx; Dil Cib, muscles dilataateurs cibariaux; Cl, clypéus; A, tracé de l'insertion de l'antenne; F, cibarium (fulcrum); Ph, pharynx et ses dilataateurs; O, tracé de l'oeil; POcc, postocciput; T, tentorium; C, cardo et muscle génocardinal; St, stipes et muscle tentorio-stipital; M T Md, muscle tentorio-mandibulaire; M Lac, muscle lacinal; M G Md, muscle génomandibulaire; M Cr Md, muscle cranio-mandibulaire; Lac, lacinia; Pm, prémentum; H, hypopharynx; PGL, sclérite du plancher de la gouttière labiale.

ayant leurs origines sur la partie centrale du clypéus, d'une part et d'autre part deux muscles moteurs ayant leurs insertions sur l'apophyse et dont les origines sont craniennes pour l'un et tentoriales pour l'autre (M Fulcr. 1). L'ensemble de la pompe cibariale — qui, chez les formes évoluées, est appelée fulcrum — est solidement fixé aux stylets impairs de la trompe et, comme la trompe, immobile.

Chez certains Orthorrhaphes (*Bombylius*, *Stratiomys*), sur lesquels nous ne pouvons insister ici, et chez les Cyclorrhaphes de nouvelles connexions s'instaurent d'emblée, donnant à l'ensemble clypéo-labrum une individualité et une mobilité propres. Cet organe sera dorénavant désigné par le terme "fulcrum", élément essentiel du rostre. Ces connexions sont :

1) la "membranisation" du territoire clypéal. Celui-ci est dorénavant divisé en trois zones : une zone marginale sclérifiée solidaire de la capsule céphalique; une zone intermédiaire membraneuse et souvent très extensible et une zone interne sclérifiée de conformation variable portant les origines des dilatateurs cibariaux et que nous appelons "centroclypéus".

2) la soudure du cibarium ou plus exactement des rebords de la gouttière que forment les prolongements épipharyngiens et hypopharyngiens avec le centroclypéus soit par une tige très étroite (*Bombylius*) soit par une "plaque" plus ou moins large (Muscides p. ex.). Cet ensemble appelé "fulcrum" constitue l'ossature de la pompe cibariale et est le levier d'érection de la trompe. Des deux muscles moteurs présents chez *Tabanus*, seul le M Fulcr 1 subsiste, mais reporte son origine du tentorium sur la zone marginale de clypéus.

3) la dislocation de la liaison avec les stylets de la trompe, remplacée par une articulation. Cette articulation est soit jointive : c'est le cas des *Aschiza* et, parmi les Schizophores, des Conopoidea et des Acalyptatae; ou bien cette articulation se fait par l'intermédiaire d'un sclérite appelé "hyoïde" découpé dans les prolongements de l'épipharynx et de l'hypopharynx.

Par suite de ces nouvelles connexions et enfin par l'adjonction d'éléments maxillaires (Gouin, 1948), cette partie clypéo-cibariale est nettement individualisée et invaginable dans la tête, car le centroclypéus pivote autour du rebord frontal de la capsule céphalique.

Le rostre ne varie guère dans son ensemble; mais il peut être modelé de diverses façons : tantôt le rostre et la trompe sont courts (*Acalyptatae*) tantôt ils sont longs (*Eristalomyia*, *Calliphora*, *Pupipara*). Ou bien le rostre est court et la trompe longue (*Glossina*); *Stomoxys* est intermédiaire entre *Calliphora* et *Glossina*. Chez quelques formes piquantes à trompe et rostre longs (*Stomoxys* et *Pupipara*), l'hyoïde est remplacé par une structure "trachéoïde" de la portion stomodéale reliant le canal alimentaire de la trompe à celui du fulcrum.

Par contre, le centroclypéus présente des modifications et une évolution assez caractéristiques. Chez *Eristalomyia* il est étroit et allongé, comme chez les Conopides; chez les Acalyptatés, il a la forme d'un arc étroit surplombant un fulcrum court et évasé donnant à l'ensemble l'aspect d'un étrier. Son évolution est plus marquée chez les Calyptatés : en fer à cheval plus ou moins rectangulaire chez les Muscides lécheurs et chez *Stomoxys*, il est particulièrement développé chez *Calliphora* et les Tachinaires, chez lesquels il s'articule au front par l'intermédiaire d'une pièce rectangulaire sclérifiée découpée dans la zone marginale postérieure du territoire clypéal et que nous appelons "postclypéus" (PCI, cf. fig. 2)<sup>1</sup>. L'évolution tend vers une réduction chez les Glossines

<sup>1</sup> Cf. Graham-Smith.

d'une part où le Centroclypéus se présente sous deux petits sclérites triangulaires (cf. Jobling) et d'autre part chez les Hippoboscides. Deux étapes peuvent être reconnues chez ces derniers : le stade *Hippobosca*, où le centroclypéus, encore superficiel dans la membrane rostrale, a la forme d'un s'articulant au bord frontal et le stade *Melophagus*, représentant l'ultime réduction possible. Le centroclypéus y est représenté par deux petites baguettes forment une fourche largement ouverte; mais il est interne. (cf. Jobling). Dans tous les cas, le centroclypéus porte les origines des dilatateurs cibariaux.

Le fulcrum varie parallèlement au centroclypéus : il est large et long chez les formes possédant un centroclypéus bien développé (Muscides, Tachinaires); il l'est moins et ses parois latérales sont moins larges chez les formes, comme les Hippoboscides, dont le centroclypéus est lui-même réduit.

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## DIE DORSOVENTRALEN MUSKELN IM PTEROTHORAX DER NEUROPTEROIDEN INSEKTEN

Von *Ossian Larsén*

In den flügeltragenden Segmenten der meisten pterygoten Insekten lassen sich die folgenden dorsoventralen Muskeln unterscheiden: die tergo-sternalen Flügellevatoren, die vom Notum nach dem Sekundärsternum ziehen und ventral vor den Hüften angreifen, die tergalen Beinmuskeln und die zwischen den Phragmen und den sternalen Apophysen verlaufenden Muskeln. Die nachstehend vorgebrachten Gesichtspunkte beziehen sich auf die dorsoventralen Flugmuskeln und die tergalen Beinmuskeln.

Im Zusammenhang mit der Entwicklung des Flugapparates haben gewisse dorsoventrale Muskeln der pterothorakalen Segmente ihre ursprüngliche Funktion als Bewegungsmuskeln der Extremitäten eingebüsst oder nur in gewissem Grade beibehalten und werden statt dessen beim Flug angewandt. Im Zuge dieser Entwicklung erfahren die betreffenden Muskeln verschiedene anatomische und histologische Veränderungen.

Bei einer Reduktion der Muskulatur des Flugapparates läuft die Rückbildung der dorsoventralen Flugmuskeln der Reduktion der dorsalen Längsmuskeln parallel, was bei den pleural gelegenen direkten Flugmuskeln in der Regel nicht der Fall ist.

Es kann leicht festgestellt werden, welchen Muskeln des Prothorax und der abdominalen Segmente die als indirekte Flügeldepressoren wirkenden dorsalen Längsmuskeln der pterothorakalen Segmente entsprechen. Was die tergo-sternalen Flügellevatoren betrifft, ist die Homologie aber nicht so klar. Nach einer Ansicht können diese Muskeln vom tergalen Promotor der Subcoxa abgeleitet werden. Vorausgesetzt, dass die Subcoxaltheorie (s. Snodgrass 1927, Weber 1928) Gültigkeit besitze, so müssen die Bewegungsmuskeln der Subcoxa entweder verschwunden oder verschoben sein bzw. einen Funktionswechsel erfahren haben.

Im Prothorax vieler Insekten sind zwei tergale Beinmuskeln vorhanden, die am hinteren Teil des proximalen Hüfttrands angreifen. Der eine setzt unweit des coxapleuralen Angelpunktes, der andere weiter medial an. Die pterothorakalen Segmente weisen bei den meisten Insektengruppen ebenfalls zwei hintere tergale Beinmuskeln auf, von denen der eine seiner hauptsächlichsten Funktion nach ein indirekter Flugmuskel, Flügellevator, ist, dessen ventraler Ansatzbezirk sich über einen grossen Teil der hinteren Hüftwand verbreitet hat, weshalb ich ihn in einer früheren Schrift als den inneren hinteren tergo-coxalen Muskel oder, wenn ein Meron ausgebildet ist, als den tergomeralen Muskel bezeichnet habe, während der andere, der äussere hintere tergo-coxale Muskel, seinen Charakter als Beinremotor beibehalten hat. Man kann dies schon bei primitiven Pterygoten beobachten, eine Tatsache, die in der entomologischen Literatur nicht ausreichend beachtet worden ist.

Viele Autoren haben sich bemüht, die homologischen Beziehungen in bezug auf die thorakale Skelettmuskulatur verschiedener Insektengruppen klarzulegen.

Es bietet recht grosse Schwierigkeiten, sich durch komparative Untersuchungen eine Auffassung von dem Grundtypus der Anordnung der Muskulatur in den Thorakalsegmenten zu bilden, weil nämlich die ursprüngliche Verteilung der Muskulatur durch Veränderungen verschiedener Art durcheinander gebracht worden sein kann.

Im folgenden will ich die dorsoventrale Muskulatur des Thorax bei verschiedenen Ordnungen der Überordnung *Neuropteroidea* (s. Weber 1933) besprechen.

Es ist kennzeichnend für die neuropteroiden Insekten, dass die Hüften der pterothorakalen Segmente sich enger an den Segmentstamm angeschlossen haben. Dabei haben einige dorsoventrale Muskeln, die ventral an der Hüfte oder am Trochantinus angreifen, Veränderungen erfahren, die entweder in einem Funktionswechsel zum Ausdruck kommen oder auch ein Verschwinden der Muskeln bedeuten.

Durch den festeren Anschluss der Hüfte an den Segmentstamm wird die Beweglichkeit der Hüfte sehr beschränkt. Die kleinen Bewegungen, die die Hüfte trotzdem machen kann, erfolgen unter Mithilfe pleuraler und vor allem sternaler Muskeln. Die Beweglichkeit, die bei anderen Insekten das Gelenk zwischen Segmentstamm und Hüfte besitzt, ist bei den meisten Neuropteroiden auf das coxatrochanterale Gelenk übertragen. Beispielsweise bei Lepidopteren ist die coxale Muskulatur reicher als bei anderen Insekten entwickelt. Die Hüfte bildet bei den Schmetterlingen distal zwei ziemlich lange schmale Fortsätze, die an der Bildung der beiden Angelpunkte des dikondylen coxatrochanteralen Gelenks teilnehmen. Weil die betreffenden Fortsätze eine grosse Elastizität besitzen, kann das Femur unter Einwirkung der an der Trochantersehne inserierenden und der coxalen Muskeln in verschiedenen Ebenen gelenkig bewegt werden. Bei den Dipteren, vor allem den höheren, hat das Meron im Mesothorax sich enger an die Segmentwand angeschlossen. Der übrige Teil der Hüfte besitzt aber eine grössere Beweglichkeit.

Die Muskulatur ist in den beiden pterothorakalen Segmenten der Neuropteroiden im wesentlichen gleich. Eine Ausnahme bilden die Dipteren. Die folgende Darstellung bezieht sich in erster Reihe auf den Mesothorax.

Als Vertreter der Megalopteren habe ich *Sialis flavilatera* L. gewählt. Bei dieser kann man drei Angelpunkte zwischen dem Segmentstamm und der Coxa beobachten, und zwar einen pleuralen, einen sternalen und einen trochantinalen. Weil der ziemlich lange aber starksklerotisierte Trochantinus mit der praecoxalen Brücke fest verbunden ist, wird die Beweglichkeit der Hüfte stark beschränkt.

Ein in zwei Portionen aufgespaltener tergosternaler Muskel ist beiderseits ausgebildet. Weber (1928 u. 1933) gibt an, dass bei *Sialis* der tergotrochantinale Muskel fehle. Das stimmt nicht mit meinen Beobachtungen überein. Am lateralen Teil des Trochantinus greift ein pleuraler Muskel an, der dorsal an einer bei den meisten neuropteroiden Insekten ausgebildeten Sehnentasche des Episternums ansetzt.

Der an der Trochantersehne inserierende tergle Muskel ist gross. Sowohl der innere als der äussere hintere tergocoxale Muskel sind ausgebildet und beide sind indirekte Flügellevatoren. Der erstere, der der stärkste ist, greift am Meron, der letztere am Hüftrand an.

Die Anordnung der dorsoventralen Muskulatur von *Chrysopa* (*Neuroptera plannipennia*) ist im grossen ganzen dieselbe wie bei *Sialis*. Der Trochantinus bildet eine freie Platte.

Bei *Panorpa communis* L. (*Mecoptera*) ist der tergosternale Muskel einfach. Der tergotrochantinale ist schmaler als der tergosternale. Der fadendünne Trochantinus ist mit seinem lateralen Ende mit der praecoxalen Brücke verbunden. Sein mediales Ende artikuliert mit dem Hüftrand. Ein ziemlich grosser tergomerale Muskel ist ausgebildet, während der äussere hintere Tergocoxalmuskel, der dem normalen Beinremotor entspricht, offenbar fehlt. Es gibt bei *Panorpa* keinen Muskel, der dem bei *Sialis* und *Chrysopa* zwischen dem Trochantinus und der Sehnentasche ziehenden Muskel entspräche.

Die Trichopteren, von denen ich verschiedene Arten untersucht habe, besitzen einen deutlich ausgebildeten, ziemlich starksklerotisierten, langen und schmalen Trochantinus, der lateral fest mit der praecoxalen Brücke vereinigt ist und medial ein Gelenk mit dem Hüfttrand bildet. Der in zwei Portionen aufgespaltene tergosternale Muskel ist bedeutend mächtiger als der tergotrochantinale.

Der obere Teil des Merons bildet die Ansatzfläche des einfachen inneren hinteren tergocoxalen Muskels. Der äussere hintere tergocoxale Muskel scheint zu fehlen.

Von den Lepidopteren habe ich Vertreter verschiedener Familien untersucht. Von diesen zeigte *Hepialus humuli* L. die grösste Übereinstimmung mit den Trichopteren, was die primitive Stellung der Hepialiden innerhalb der Ordnung bestätigt. Der Trochantinus ist nämlich bei dieser Art noch ein selbständiges Sklerit.

Das vordere Basicoxale (s. L a r s é n 1945 a), das nur medial ausgebildet ist, biegt sich nach hinten über die Basicosta hinein. Es ist fast membranös aber doch formbeständig. Der Trochantinus liegt auf diesem Basicoxale und schmiegt sich eng an dieses an. Der Hinterrand des Trochantinus ist mit dem nach hinten gekehrten Rand des Basicoxale verbunden. Die Muskulatur zeigt dieselbe Anordnung wie bei den Trichopteren. Der innere hintere tergocoxale Muskel greift sowohl im Meso- als Metathorax am Meron unterhalb der hinteren Basicosta an.

Bei höheren Lepidopteren ist der Trochantinus eng mit dem vorderen Basicoxale und der Basicosta verschmolzen. Dieser Komplex bildet eine hohe Leiste, die von W e b e r (1928) als die Basicosta bezeichnet wird. Wie aus dem oben Gesagten hervorgeht, wird nur der laterale Teil der Leiste ganz von der Basicosta gebildet. An diesem Teil greift der coxabasale Muskel an.

Am medialen Teil der ebenerwähnten Leiste, in dem der Trochantinus aufgegangen ist, greift der tergotrochantinale Muskel an.

Der tergotrochantinale Muskel ist schwächer als der tergosternale, der bei den meisten Lepidopteren in zwei oder mehrere Portionen aufgespalten ist. Ein trochantinobasalarer Muskel ist weder bei *Hepialus* noch bei den höheren Lepidopteren ausgebildet.

Der innere hintere tergocoxale Muskel greift z. B. bei *Vanessa* im Mesothorax an der Basicosta, im Metathorax weiter unten am Meron, bei den meisten übrigen Lepidopteren sowohl im Meso- als Metathorax am Meron an. Der äussere hintere tergocoxale Muskel fehlt.

Die nun behandelten neuropteroiden Insekten, Megalopteren, Plannipennien, Mecopteren, Trichopteren und Lepidopteren bilden nach der Anordnung der Thorakalmuskulatur zu urteilen eine natürliche Gruppe. Ein gemeinsamer ug bezüglich der dorsoventralen Muskulatur liegt darin, dass die tergotrochantinalen und tergocoxalen Muskeln, wenn sie ausgebildet sind, ihre Funktion als Bewegungsmuskeln des Beins aufgegeben haben und in den Dienst des Flugmechanismus getreten sind.

Bei den Dipteren hat das Meron des Mesothorax sich eng an den Segmentstamm angeschlossen. Die Vereinigung ist bei den verschiedenen Gruppen verschieden fest. Der tergosternale Muskel ist gross. Der tergotrochantinale wie der äussere hintere tergocoxale Muskel fehlt. Der tergomerale Muskel ist vorhanden, kann aber natürlich keinen Einfluss auf die Bewegungen der Hüfte ausüben, weil das Meron von der Hüfte getrennt ist und sich fest mit der Segmentwand vereinigt hat.

Ich gebe die für das flügeltragende Segment typischen dorsoventralen Muskeln folgendermassen an: 1) den tergosternalen, 2) den tergotrochantinalen, 3) den vorderen tergocoxalen, 4) den tergotrochanteralen, 5) den inneren hinteren tergocoxalen oder

tergomerale, 6) den äusseren hinteren tergocoxalen und 7) den zwischen Phragma und Furca ziehenden Muskel.

Der tergosternale Muskel soll nach einer allgemein gehegten Ansicht vom primären Promotor der Subcoxa abgeleitet werden können. Es gibt aber im Prothorax der Pterygoten oder im Meso- und Metathorax der Apterygoten d. h. primär ungeflügelten Segmenten, keinen Muskel, von dem man mit Sicherheit sagen kann, dass er dem tergosternalen Muskel entspreche. Ich neige am ehesten zu der Annahme, dass der fragliche Muskel als eine Neubildung zu betrachten sei, deren Entstehung mit der Entwicklung des Flugapparates zusammenhängen dürfte.

Der tergosternale Muskel ist bei vielen Insekten einfach, bei anderen aufgespalten. Ich finde keinen triftigen Grund für die Ansicht, dass die typische Anzahl der tergosternalen Muskeln zwei sei.

Der tergotrochantinale Muskel ist ursprünglich ein Promotor der Extremität. Nach Snodgrass (1935) kann der Trochantinus bisweilen mit den ventralen Teilen des Episternums vereinigt werden. Wie ich bei den höheren Lepidopteren gefunden habe, kann der Trochantinus aber auch mit dem Hüfttrand verschmelzen. In Verbindung damit, dass die Hüfte sich enger an den Segmentstamm angeschlossen hat, kann der tergotrochantinale Muskel seine ursprüngliche Funktion als Beinbeweger verlieren und ein indirekter Flugmuskel, Flügellevator, werden. Dies ist gerade bei den neuropteroiden Insekten der Fall.

Der tergotrochanterale Muskel behält immer seine Funktion als Depressor des Trochanters.

Die beiden hinteren tergocoxalen Muskeln können wahrscheinlich von einem primär einfachen tergalen Beinremotor abgeleitet werden. Der innere hintere (tergomerale) Muskel ist kein Beinremotor, sondern ein indirekter Flugmuskel, Flügellevator.

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## PHYLOGENY OF THE HOMOPTERA AUCHENORHYNCHA

By Z. P. Metcalf

When one attempts to discuss the phylogeny of a group as large and as varied as the Homoptera he at once finds himself hedged about by so many restrictions that I thought I would be quite poetic and say that I found myself impaled on a trident. But after careful consideration I find that the limitations are so many times three times three that such an expression not only loses its scientific verity but it so far exceeds the bounds of poetic license as to lose all reality.

On the one hand we are confronted by the abundance of materials. The group as now recognized comprises no less than 2 cohorts, 6 superfamilies, 43 families, 195 tribes, 3,200 genera, and about 30,000 species have been recorded. Of course no one individual can possibly know any such vast assemblage intimately enough to know whether these categories are valid or invalid. Assuming that the genera and species now known are all valid, the question naturally arises, are the species assigned to the right genera, and are the genera assigned to the right families, and so on into the higher groups. Both of these statements need verification before we proceed with our discussion of phylogeny but again we find ourselves in a strange dilemma. Further progress in the solution of the problem of correct assignment of genera and species is directly dependent upon the development of our knowledge of phylogeny. Thus science finds itself always in a state of unbalance as it inches its way forward. Science is always like a man walking who puts forward one foot to regain his balance only to find that he must put forward his other foot to balance himself on the other side. Thus the segregation of new genera and species may necessitate the rearrangement of some of the branches of our phylogenetic tree. And this phylogenetic rearrangement will call for a restudy of the included genera and species.

Turning in another direction we find our way barred to a complete understanding of the phylogeny of the group by the fact that our knowledge of this order of insects is as yet so incomplete. This defective record can be illustrated best by the consideration of a few concrete examples. Bruner and his associates collecting these insects in Cuba incidentally to their other duties have shown that a presumably limited fauna of 57 genera and 125 species known from the island before 1920 is actually represented by at least 57 genera and 147 species, from the study of only 6 of the 30 families represented on the island. A single American soldier limited to collecting in a single valley in New Guinea during his spare time has collected no less than 900 species whereas previous to 1940 we knew only some 200 species from this vast tropical island. The records from other regions are similar.

Our knowledge of genera and species, especially in certain families, is fairly complete. Such regions as Europe and the United States have been fairly well studied for many groups. But, for other groups, even these regions are poorly known. The recent studies of three genera of North American leaf hoppers, *Empoasca*, *Typhlocyba* and *Erythro-neura*, by such students as Beamer, De Long, Knull, Oman and others, illustrate the results that may be expected when other genera are as carefully studied. The species of these three genera are almost exclusively pale green insects, sometimes with varieties that are vittate, fasciate or spotted with bright red, but for the most part without evident external specific characters. Using the characters of the male genitalia as

criteria in the study of specific limits in these genera these students have revealed that what were considered as small genera with only a few species a quarter of a century ago, now stand revealed as genera with a large number of species. Gillette (1898) in his monographic study of this group of leaf hoppers described 28 species of *Empoasca* and 21 species of *Typhlocyba* and *Erythroneura*. In 1917 Van Duzee cataloged 32 species of the genus *Empoasca*, 11 species of *Typhlocyba* and 14 species of *Erythroneura*; but today we know no less than 99 species of *Empoasca*, 57 species of *Typhlocyba* and 296 species of *Erythroneura*. Therefore, any theories that are advanced today about genera and species of Homoptera are purely tentative and will be subject to constant revisions until that happy day when we know more thoroughly their taxonomic and geographic limits. Homoptera from the other regions of the world have been studied only superficially. Many genera have been poorly defined. This is in part due to a failure to appreciate true morphological characters. It is due in part, at least, to the fact that the generic characters inherent in phallic structures have not been recognized. And it arises from a lack of consideration of the importance of delineation of zoogeographic regions as fundamental characters in the definition of genera.

If we turn in still another direction we are faced with the same conditions. Comparative morphology is the corner stone of phylogeny but our knowledge of the comparative morphology of even the better known genera is very incomplete. This is said in spite of the fact that we have had fairly recent studies of the Homopterous head, of the male genitalia and the wings of these insects. Practically nothing has been done on the thorax recently. Most of these studies have been made from too limited a point of view to furnish satisfactory ground work for the discussion of the true phylogeny of this order of insects. Many of these studies have been made with the idea that the Cicadidae are the most primitive of the Homopterous insects—a conclusion I believe I shall be able to disprove later. Then, too, in any study of comparative morphology we are confronted with the differential development of the various parts of the insect's body. Thus the head may be relatively primitive, the wings highly developed, the legs simple and the genitalia complex in one group, whereas in another group we are confronted with a different combination of characters.

The fragmentary paleontological records are of no material assistance in the solution of our problem. Practically all the fossils which belong without question to the Homoptera are assigned to recognized recent genera or are very closely related to them. There are no intermediate forms which might help us solve some of the problems of phylogeny.

We are confronted with a similar problem when we turn to embryology to help us solve some of our most perplexing problems. Many years ago I made an extended study of the embryology of the periodical cicada (*Magicicada septendecim* Linne) in the hope that it would aid in the solution of the problem of the regions and sclerites of the head. But aside from reaffirming the well-known fact that insect mouth parts are developed from leg-like embryonic buds, the study led to no worth-while conclusions. In spite of these and other limitations, I am nevertheless inclined to advance some ideas in regard to the phylogeny of the group as a whole. Our present concepts of the phylogeny of the Homoptera is substantially the same as that established by Stål in the middle of the last century when we knew approximately 222 genera and 3,259 species over against the 3,200 genera and 30,000 species known today. Students in those days recognized five families; the present scheme lists forty-

three families. It can be readily seen therefore that we have made tremendous strides in taxonomy over the past century. But unfortunately our studies of phylogeny have not kept pace with this great development in taxonomy. Elsewhere I have expressed my dissatisfaction with our present concepts of genera (Metcalf 1947a). But in the present instance I am concerned principally with the groups higher than the family. If we are to express ourselves clearly and distinctly about the phylogeny of this or any other order of insects we need a better terminology and a better understanding of the categories necessary. We need to appreciate the importance of this area of our phylogenetic tree. To this end I would like to propose the following phylogenetic categories as essential in many if not all cases to express our ideas of the evolutionary descent of insects of this order:

Order  
Suborder  
Legion  
Phalanx  
Cohors  
Division  
Section  
Superfamily  
Family  
Subfamily  
Tribe  
Supergenous  
Genus  
Subgenus  
Species

Now if we could get a toe hold on this phylogenetic stairway, if someone could define the word species in such a manner that it would be uniformly acceptable to all entomologists or if we had a set of tests so that entomologists studying an order of insects could apply the tests and determine whether previously described species were valid or whether a given specimen belonged to a species as yet undescribed, most of our problems would be solved and we could trip lightly up or down this phylogenetic stairway with the greatest of ease. But for the present at least, such a goal is so distant that you will pardon me if I do not dwell on this subject but hasten to outline the phylogenetic tree for the insects of the order Homoptera in bold strokes, leaving the details to be filled in by scientists of future generations in the slow laborious manner so characteristic of science.

There are certain basic principles which must be clearly understood before we can make much progress in studying phylogeny. The first of these is what I am pleased to call the purely tentative principle in science. We are apt to think of science as the product of the scientific method and to consist therefore of an accumulated body of facts. Unfortunately, this is not true. Even a cursory examination of the history of science covering only the years of the youngest of us here will show quite clearly how tentative are all our conclusions. Instead of discouraging us however, this discovery should stimulate us to ever greater and greater efforts to solve these mysteries. Parenthetically and facetiously may I inject here the idea that if the human race had waited until civilization was perfect we would still be swinging from our prehensile tails in a tropical jungle somewhere instead of finding ourselves in the middle of the Atomic

Age, and not knowing quite what to do about it. Yet in spite of this past history and the evident instability of our scientific knowledge we assume that our present knowledge is complete, whereas the only true progress that can be made is for this generation to do its best to produce a science that must be reconstructed by the next generation.

The basis for true phylogeny must be comparative morphology. The obvious pitfall here is that we misconstrue apparent or superficial characters and completely overlook basic but cryptic characters. There is a real and fundamental difference between making keys and constructing synopses. In making keys we are erecting guide posts to direct the traveller in a strange land. In constructing phylogenetic synopses we are attempting to direct the traveller's attention to the fundamental relationship of the people who live in these strange lands.

There is a fundamental principle in comparative morphology that is too frequently overlooked. This is that synoptic characters must apply to all members of a group. Thus they must be at one and the same time mutually inclusive and mutually exclusive.

There is another fundamental principle of comparative morphology that is frequently misconstrued. This is the fact that appendages and similar structures are always associated with the same sclerites or regions of the body. Any deviations from this rule are apparent only, not real. Thus in the fulgorids the sinus of the compound eyes is directed ventral and the antennae are ventral to the sinus. But in the tribe Bothriocerini the sinus is apparently directed cephalad and the antennae are situated apparently cephalad to the sinus due to the twisting of the head.

Regions and areas are often confused. Typically there are six surfaces on the insect's body: dorsal and ventral, two lateral and cephalic and caudal. The dorsal area of the head is the crown, the cephalic area is the face and the lateral areas are the cheeks. The crown may be composed largely or exclusively of the region we call the vertex, or largely of the region we call frons with the vertex concealed or even of the postclypeus with vertex and frons reduced or lost. In the same way the face may be composed in large part of anteclypeus, postclypeus, frons or vertex or by all sorts of combinations of these regions.

Each group must be analyzed for these factors and their interrelations understood before we can have a clear understanding of the true phylogenetic groups involved.

In a class as ancient geologically speaking as the Insecta, it might be assumed that most fundamental characters would be fixed. But unfortunately this does not seem to be the case. Not only are we bedeviled by the differential development of the various parts of the insect's body but also by the plasticity of protoplasm which is a fundamental, but too frequently unappreciated, property of this mysterious living substance. For example, wing venation of the Homopterous insects is perhaps better understood than any other area of comparative morphology of the Homoptera, but when we attempt to settle questions of phylogeny by appeal to wing venation we find in the Homoptera no less than three distinct types of tegmina: a very short fore wing with reduced venation, covering the basal segments of the abdomen only—*brachypterous*; or of moderate length covering most of the abdomen and with fairly well developed venation—*koeliopterous*; and lastly a fore wing usually longer than the abdomen, frequently much longer, with fully developed venation—*macropterous*. Not only are whole families characterized by one or another type of tegmina but sometimes all three types are found not only in the same family, but frequently in the same genus sometimes in the same species.



I hope that sometime our techniques will improve sufficiently so that comparative embryology may contribute its fair share to the solution of the difficult problems of phylogeny.

Then, too, I am sure that the center of origin theory and a restudy of zoogeography will clear up many otherwise obscure areas in the total picture. A very superficial study of certain genera of the Homoptera has proven the usefulness of this tool in the resolution of complex relationships and I hope that if it is properly used it will prove equally useful in the solution of the complex relationships of the higher groups.

And while I realize the limitations of the materials and ideas expressed here, I cannot help but attempt to bring the facts, as I see them, into a correlated system which I trust will stimulate others to improve on this effort which makes no other claim to fame.

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# SUR UN PHÉNOMÈNE DE PHORÉSIE DES SPERMATOZOÏDES PAR DES CELLULES OVIDUCTAIRES, CHEZ *Aspidiotus ostreaeformis* curt. (Hemiptera — Homoptera — Coccoïdea)

Par P. Pesson

*Aspidiotus ostreaeformis*, comme la plupart des *Diaspidinae* est une espèce ovovivipare, émettant lors de la ponte des oeufs qui renferment un embryon complètement développé. C'est une espèce bisexuée et les femelles sont normalement fécondées. Histologiquement on retrouve toujours les spermatozoïdes dans la spermathèque et dans les oviductes.

Le tractus génital comporte un canal impair s'ouvrant à la vulve, canal pourvu d'une intima chitineuse et d'une tunique musculaire et désigné comme vagin ou canal ovarien. Il reçoit à son extrémité deux oviductes s'écartant latéralement comme les branches d'un V, et à la jonction de ceux-ci, un réceptacle séminal ou spermathèque.

Chaque oviducte porte de nombreux ovarioles disposés en grappe, les plus développés étant insérés vers l'apex de l'oviducte, les plus jeunes vers la jonction avec le vagin. Chaque ovariole se différencie aux dépens de quatre cellules qui font rapidement hernie à la surface de l'oviducte, et se trouvent alors entourées d'une enveloppe épithéliale qui demeure reliée à la paroi par un tractus, Fig. 1 A. De ces quatre cellules, trois se disposent en calotte sur la 4<sup>ème</sup>. qui demeure infère, elles évolueront en cellules nourricières tandis que seule l'autre cellule donnera un ovocyte, Fig. 1 B. Avant ce stade toutes ces cellules demeurent incluses et confondues dans la paroi de l'oviducte.

Cet ensemble va se développer en donnant un ovariole. Les trois cellules nourricières croissent plus vite que l'ovocyte, leur noyau devient très volumineux recouvert seule-

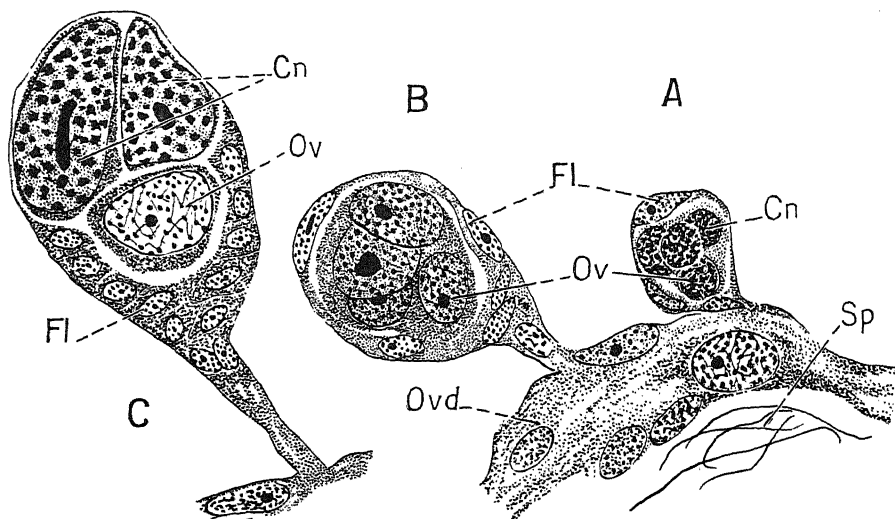


Fig. 1. Trois stades successifs A, B, C, du développement d'un ovariole chez *Aspidiotus ostreaeformis*. Ovd, cellules de la paroi de l'oviducte. Cn, cellules nourricières. Ov l'ovocyte. Fl, cellules folliculaires. Sp, spermatozoïdes.

ment d'un mince cortex cytoplasmique, fig. 1 C. La chromatine en est répartie en mottes irrégulières et on observe un ou deux gros nucléoles dans chaque noyau dont le suc nucléaire demeure encore très basophile bien qu'il le soit moins qu'à un stade plus précoce. Le noyau de l'ovocyte par contre, devient de plus en plus clair avec une chromatine finement granuleuse répartie sur un réseau de linine très délicat. Quant à l'enveloppe cellulaire du complexe ovocyte+cellules nourricières elle s'est considérablement amincie au niveau des cellules nourricières tandis qu'autour de l'ovocyte les cellules, qui se sont beaucoup multipliées, forment un épithélium cylindrique unistratifié qui se prolonge par un cordon cellulaire inséré sur l'oviducte.

A un stade plus avancé, l'ovocyte va témoigner d'une forte croissance cytoplasmique, cependant que le noyau devient de plus en plus clair et sa chromatine de plus en plus

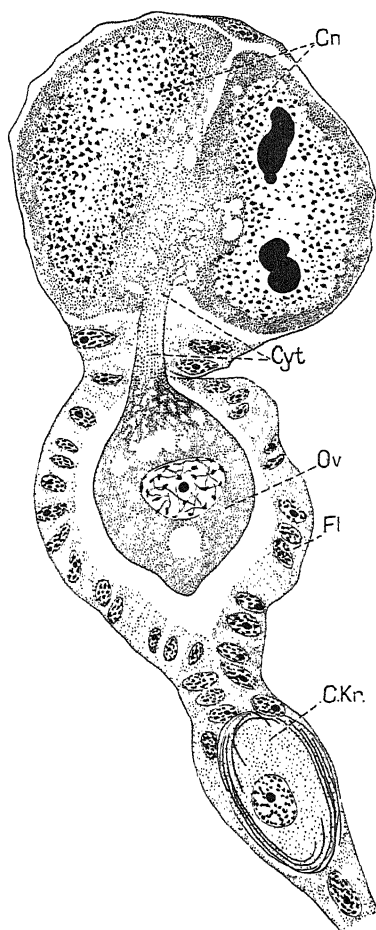


Fig. 2. Ovariole dont l'ovocyte commence sa croissance de vitellogenèse. Dans le pédoncule, cellule de *Krassil'schick*, CKr, avec ses spermatozoïdes. Cyt, cordon cytoplasmique reliant les cellules nourricières à l'ovocyte.

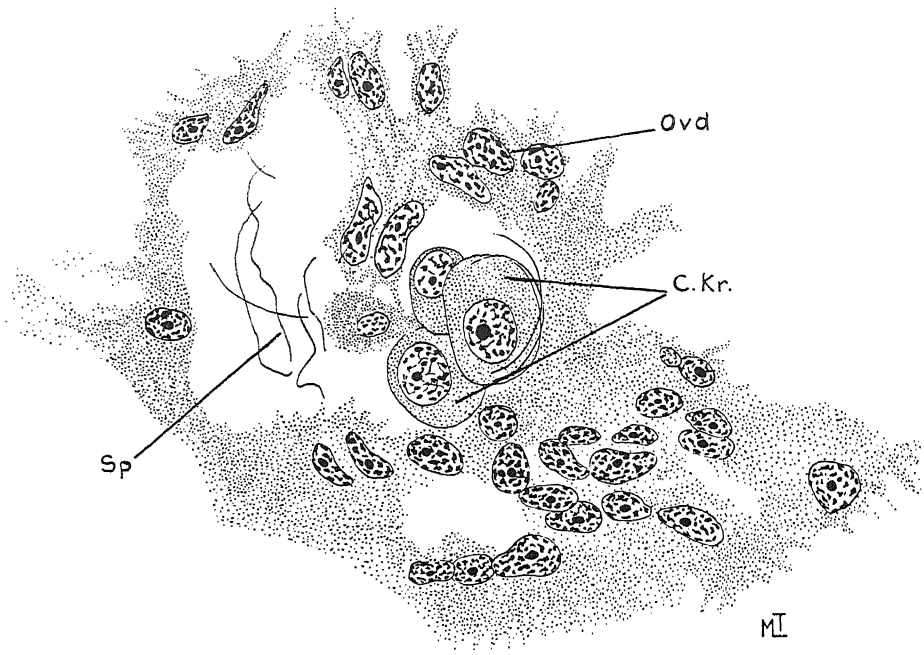


Fig. 3. Premiers stades identifiable des cellules de Krassil'stchick Ckr, dans l'oviducte d'*Aspidiotus ostreaeformis*. Ovd, cellules des parois de l'oviducte. Sp, spermatozoïdes.

diffuse. Cette croissance est en rapport avec une vitellogenèse intense assurée en majeure partie par les cellules nourricières qui se trouvent alors reliées à l'ovocyte par un cordon cytoplasmique se fondant de part et d'autre dans le cytoplasme de l'ovocyte et celui des cellules nourricières, fig. 2. Ces dernières offrent alors l'aspect d'une intense activité sécrétoire. Leur noyau devient polymorphe, à contour crénelé ou dentelé, les nucléoles sont très volumineux et la chromatine très abondante forme des amas plus ou moins complexes et de grosseur variable.

Tous les ovarioles ayant ébauché cette étape de la vitellogenèse montrent alors, dans le pédoncule sous-jacent à l'ovocyte, une cellule particulière, régulièrement ovoïde, à cytoplasme homogène et très clair, à noyau central pourvu d'un nucléole arrondi et d'une chromatine assez dense. Cette cellule est entourée d'une sorte d'écheveau de spermatozoïdes, difficilement dénombrables (peut être une dizaine) qui sont comme pelotonnés sur la cellule contre laquelle ils sont étroitement appliqués, CKr, fig. 2.

Nous n'avons pu jusqu'ici préciser l'origine de cette cellule, mais il apparaît très probable qu'elle provient de la paroi interne de l'oviducte où l'on remarque de nombreuses cellules plus ou moins saillantes dans la lumière. Après la fécondation de la femelle, on observe des spermatozoïdes réunis en faisceaux dans la spermathèque et d'autres isolés et dispersés dans la cavité même des deux oviductes. On peut alors remarquer parmi ceux-ci et au voisinage de la paroi, quelques cellules, différant des éléments épithéliaux par leur forme arrondie, leur noyau régulier avec un nucléole bien

distinct, leur cytoplasme homogène et clair. Certaines de ces cellules, les plus grosses, portent, enroulés et accolés à leur surface quelques spermatozoïdes, CKr, fig. 3. Selon toute évidence ce sont ces cellules qui migreront ultérieurement dans chacun des ovarioles par la cavité de leur pédoncule. Elles assurent ainsi le transport des spermatozoïdes vers l'ovocyte. Cependant jamais on ne les observe arriver au contact même de l'ovocyte et la fécondation est finalement réalisée par la progression propre des gamètes mâles vers le gamète femelle. Ces cellules persistent assez longtemps dans le pédoncule de l'ovariole, alors que l'oeuf a subi sa segmentation et débuté son organogenèse embryonnaire, fig. 4. Ce n'est que tardivement, quand l'embryon est déjà fort avancé, que ces cellules manifestent une dégénérescence qui va en s'accroissant.

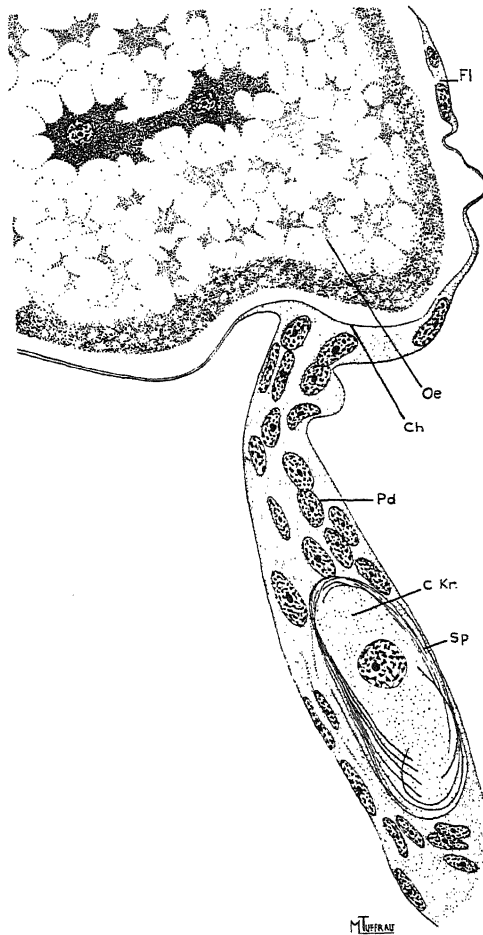


Fig. 4. Cellule de *Krassilstchick Ckr*, dans le pédoncule d'un ovariole, dont l'ovocyte fécondé *Oe*, a déjà ébauché sa segmentation. *Ch*, chorion de l'oeuf en formation. *Pd*, pédoncule de l'ovariole. Autres lettres comme sur les autres figures.

Divers auteurs, notamment A. Balachowsky (1939)<sup>1</sup>, ont déjà souligné que la fécondation des oeufs chez les Coccides, et surtout chez les espèces ovovivipares et vivipares comme les *Diaspidinae*, se fait *in situ*, c'est à dire dans l'ovariole, et non pas lors de la ponte au moment du passage de l'ovocyte devant l'ouverture de la spermathèque. Ajoutons que l'observation d'une cellule particulière portant les spermatozoïdes dans le canal de l'ovariole a déjà été décrite chez une Diaspine, *Aspidiotus nerii*, par J. Krassilstchick en 1893<sup>2</sup>, mais cette publication semble être demeurée généralement inconnue des chercheurs s'étant occupés de l'ovogenèse chez les Coccides. Si cela pouvait faciliter la désignation de cette curieuse cellule vicariante des spermatozoïdes dans l'oviducte et l'ovariole des Diaspines, je proposerais volontiers de l'appeler cellule de Krassilstchick en l'honneur de celui qui, à ma connaissance, fut le premier à la mentionner.

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<sup>1</sup> A. Balachowsky — Les cochenilles. III: Reproduction. Développement embryonnaire. Paris, Hermann et Cie. Edit., 1933.

<sup>2</sup> J. Krassilstchick — Zur Entwicklungsgeschichte der Phytophthires. (Zool. Anz., 1893, N° 413, pp. 69—76.)

## SEGMENTAZIONE DEL CORPO DEI COLOBOGNATI (Diplopodi)

Dal Filippo Silvestri †

Nel 1903 io feci conoscere il risultato delle mie ricerche<sup>1</sup> sulla segmentazione del corpo del *Pachyiulus communis* Savi, e confermai per la regione cefalica quanto aveva osservato l'Heymons nello sviluppo di *Glomeris*<sup>2</sup>, particolarmente che nel differenziarsi del segmento labiale non comparivano su di esso accenni di appendici e che restava ventralmente rappresentato solo dallo sterno; al dorso di tale segmento per primo attribuii il collo, del tutto separato dal capo e dal tronco, mentre altri autori hanno continuato a considerarlo come primo del tronco.

La Robinson<sup>3</sup> cadde in grave errore ammettendo in *Spirostreptus* sp. (dell'Africa merid.) un paio di appendici per il segmento labiale come per il mascellare e ammettendo dietro di detto segmento anche un primo segmento del tronco apodo; ma l'Attems appoggiò tale errore riportando anche la figura<sup>4</sup>.

Pflugfelder nel 1932<sup>5</sup> ripetette l'errore della Robinson per l'ammissione di un segmento labiale provvisto di appendici, di più non vide il segmento intercalare e fece innervare le antenne dai gangli di tale segmento, mentre avanti alle antenne figurò un accenno corniforme per lato a rappresentare forse l'archicerebro, che in realtà ha una forma assai diversa.

Al Congresso internazionale d'entomologia del 1932 in Parigi, io tornai sull'argomento e feci vederne disegni e preparati di piastra germinativa di *Spirostreptidae* (*Archispirostreptus gigas* Peters), che confermavano in modo indiscutibile il risultato delle mie ricerche sul *Pachyiulus* e feci notare gli errori degli ultimi due autori nominati.

In questa fortunata occasione di aver potuto prendere parte a questo Congresso voglio far conoscere il risultato delle mie ricerche condotte sui Colobognati, ordine del quale nessuno fino ad ora si era occupato e ho scelto il *Dolistenus Savii* Fanzago (Fam. *Platydesmidae*), specie non rara in alcune località dell'Italia meridionale.

*Deposizione delle uova.* Il *Dolistenus Savii* nell'Italia meridionale, come Lagonegro (Potenza), depone le uova durante il mese di giugno (nel 1938 femmine con ova cominciarono a trovarsi il 5, con prelarve uscite dal chorion il 18 dello stesso mese e larve libere il 10 Luglio).

Le femmine ovificanti hanno il tronco composto di 60 a 94 segmenti, con una maggiore frequenza tra 80 e 90.

La femmina colle ova si trova di regola in una galleria nel terreno alla profondità di pochi centimetri; essa è disposta col corpo a spira e in questa protegge le ova.

Ogni femmina depone poche ova: in quelle esaminate a Lagonegro da 3 a 19 e questi numeri furono trovati colla seguente frequenza: 3 una volta, 4 quattro volte, 5 otto

<sup>1</sup> Silvestri, F.: Classis Diplopoda. I. Anatome: in Berlese, Acari, Myr. et Scorp. Portici (1903), p. 79 e seg., figg. 127, 186, 187.

<sup>2</sup> Heymons, R.: Mittheilungen über die Segmentirung und den Körperbau der Myriopoden. — Sitz. K. Preuss. Akad. Wiss. Berlin XL (1897), p. 920, Fig. 2.

<sup>3</sup> Robinson, Marg.: On the segmentation of the head of Diplopoda. — Quart. J. micros. Sci. 51 (1907).

<sup>4</sup> Attems, C.: Myriapoda, in: Kukenthal, Handbuch der Zoologie IV (1930), p. 80, Fig. 98.

<sup>5</sup> Pflugfelder, O.: Ueber den Mechanismus der Segmentbildung bei der Embryonalentwicklung und Anamorphose von *Platyrrhacus amauros* Att.-Zeits. Wiss. Zool. Leipzig, vol. 140 (1932) p. 650—723.

volte, 6 undici volte, 7 sei volte, 8 tre volte, 9 una volta, 10 quattro volte, 11 due volte, 12 due volte, 13 una volta, 14 una volta, 15 una volta, 19 due volte.

La femmina protegge prima le ova, poi le prelarve e per qualche giorno anche le prime larve disposto con corpo a spira, come sopra ho detto.

*Ovo.* L'ovo appena deposto è di forma ellittica, lungo poco più di 1 millimetro (1.04—1.22) e largo poco più di 1/3 della lunghezza (0.78—0.84), è di colore paglierino.

*Segmentazione del corpo.* La prima piastra germinativa da me osservata nello sviluppo di questa specie (Fig. 1) presenta il capo con accenni di antenne il segmento intercalare

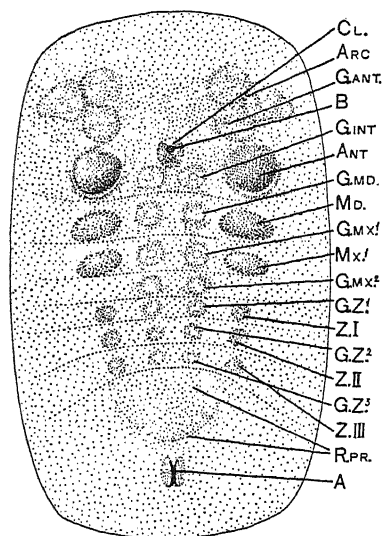


Fig. 1. *Dolistenus Savii*: Piastra germinativa lunga mm 0,65; A apertura anale; B apertura boccale; Ant antenne; Arc archicerebro; Cl clipeo; G. ant. ganglio antennale; G. Int. ganglio del segmento intercalare; G. Md. ganglio mandibolare; G. Mx 1 ganglio del segmento delle mascelle del 1° paio; G. Mx 2 ganglio del segmento labiale; G. Z<sub>1</sub>—G. Z<sub>3</sub> gangli del 1°, 2° e 3° segmento del tronco; Md mandibole; Mx 1 mascelle del 1° paio; R. PR. regione di accrescimento; Z<sub>1</sub>—Z<sub>3</sub> zampe del 1°, 2° e 3° paio del tronco.

(premandibolare) senza appendici (almeno non distinguibili), il mandibolare ed il mascellare con accenni delle rispettive appendici, il labiale senza appendici.

Al capo segue il pretronco con 3 segmenti distinti, ciascuno dei quali ha l'accenno di un paio di appendici (una per lato). Al pretronco nettamente 3-segmentato, segue il mesotronco ancora insegmentato e fornito di apertura anale allungata situata a distanza relativamente grande dal margine posteriore del pretronco.

In uno stadio più avanzato si notano accenni di zampe sui segmenti seguenti al 3° del pretronco e in corrispondenza al 6° segmento del tronco, (3° del mesotronco)



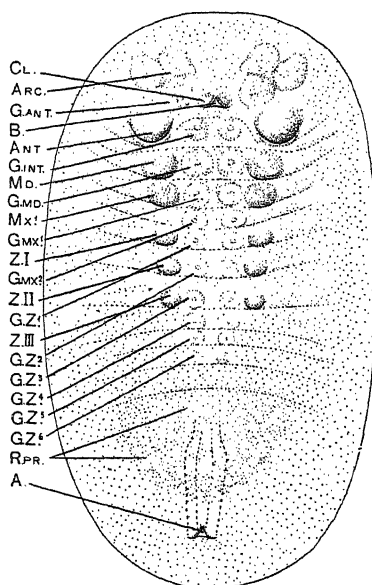


Fig. 11. *Doli sten us Savii*: piastra germinativa lunga mm 0,70: G. Z 4—6 gangli del 4°, 5° e 6° paio di zampe, le altre lettere come a fig. 1.

l'embrione va soggetto ad una infossatura, per cui comincia a diventare convesso al dorso e concavo al ventre. A tale periodo dello sviluppo il chorion dell'ovo si fende e sguscia fuori l'embrione ora formato del capo, del collo, di 3 segmenti del pretronco, del 1° e del 2° del mesotronco (o 4° e 5° dell'intero tronco), dal segmento anale e di un lungo tratto fra il 5° e l'anale poco più lungo del 5° (misurati alla parte dorsale), il quale comincia al dorso e lateralmente a mostrare accenni di segmentazione e al ventre accenni di zampe anteriormente.

In stadi più avanzati i segmenti della parte preanale diventano sempre più distinti fino a potersi contare in numero di 18 (non compresi il 1° ed il 2° che si è detto sono molto distinti quando già l'embrione sguscia dall'ovo). Ogni segmento del mesotronco si sviluppa al dorso e ai lati intero cioè senza accenni di divisione in due, mentre sul ventre ciascuno ha due sterniti e due paia di zampe.

*Prima larva libera.* Continuando lo sviluppo si ingrandiscono tutti i segmenti già ricordati e risulta così formata la prima larva libera. Questa, a sviluppo completato, ha una lunghezza di mm 6 e una larghezza (al decimo segmento) di 0,64. Il suo corpo è formato del capo, del collo, del tronco che ha 23 segmenti, dei quali i primi 3 con un paio di zampe ciascuno, i segmenti dal 4° al 22° compreso di 2 paia di zampe ciascuno, il segmento 23° con accenno non ancora sporgente di 2 paia di zampe, il segmento 24° (preanale) con accenno alla parte anteriore ventrale di altri segmenti, ed infine il segmento anale formato da due valve ed una laminetta subanale. I segmenti dal 4° al 23° sono forniti di un paio (una per lato) di ghiandole repugnatorie sboccanti all'apice posteriore delle carene.

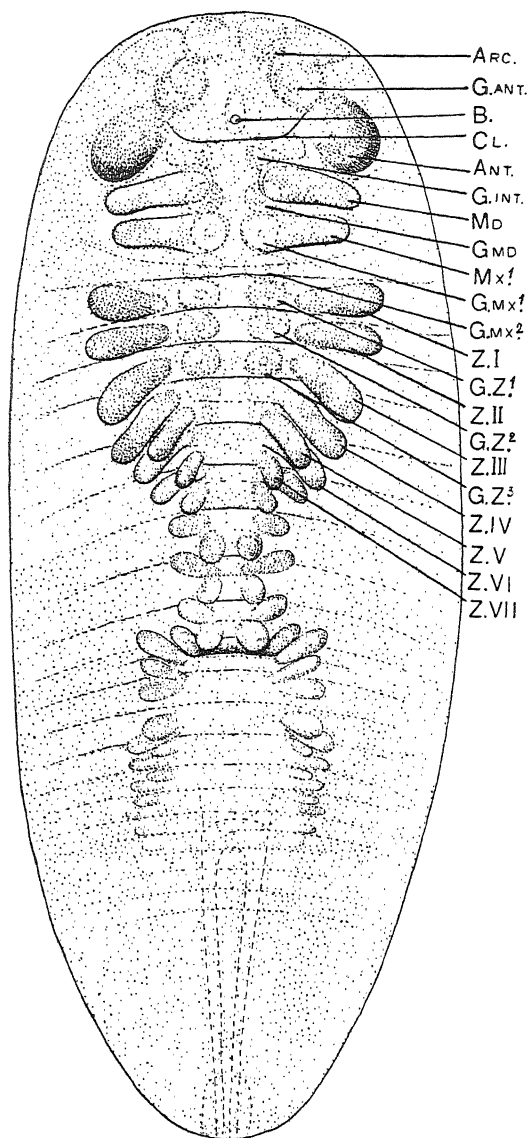


Fig. III. *Dolistenus Savii*: faccia ventrale di una prelarva lunga (distesa artificialmente) mm 1,10: Z IV—VII zampe del 4º al 7º paio, le altre lettere come a fig. 1.

Con queste mie nuove osservazioni resta completamente provato per tutti i *Diplopodi*<sup>6</sup> quanto segue:

- 1° l'apparecchio boccale è formato da due paia di appendici (mandibole e mascelle del 1° paio) e il segmento labiale contribuisce alla composizione dell'hypostoma (=gnatholicario) collo sterno formando il basile dell'hypostoma (=hypostoma Latzel et Auctorum);
- 2° i primi tre segmenti del tronco (formanti il pretronco) hanno ciascuno un paio di zampe, mentre i seguenti del mesotronco hanno due paia di zampe ciascuno; ma negli *Spirobolidae* il 4° segmento del tronco, che è il 1° del mesotronco ha soltanto un paio di zampe, perchè tutta la parte sternale colle relative zampe si è spostata durante lo sviluppo larvale in avanti in modo che le pleure del 3° segmento del tronco si sono saldate collo sterno anteriore del 4° segmento del tronco, quelle del 2° collo sterno del 3°, quelle del 1° rimaste libere hanno fra esse e l'ipostoma due paia di zampe, delle quali il 1°, se non si seguisse lo sviluppo, potrebbe essere attribuito al segmento del collo ed il 2° al 1° del tronco;
- 3° la prima larva libera dei *Diplopodi* può avere pochi segmenti e 3 paia di zampe oppure 4 paia di zampe o un numero più o meno grande di segmenti colle relative zampe (un paio ai segmenti del pretronco e due paia sui segmenti del meso-tronco);

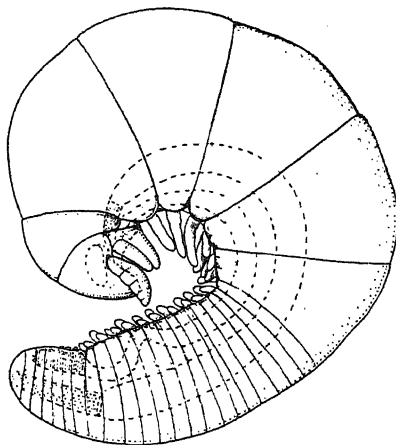


Fig. IV. *Dolistenus Savii*: prelarva, lunga nella posizione in cui è disegnata mm 1,40.

- 4° I nuovi segmenti che si aggiungono a quelli della prima prelarva e della larva libera si originano da una zona di proliferazione situata avanti il segmento anale.

#### Resumé

Dans cette note l'auteur traite de la segmentation embryonnaire des *Colobognathes* (*Diplopodes*). Il rappelle les résultats de Heymons (1897) concernant une espèce du genre *Glomeris* et ses propres résultats (1903) concernant *Pachyiulus communis* (Savi), en raison des quels il fut démontré que la région cephalique de l'embryon comporte

<sup>6</sup> Sono solo da studiarsi i *Penicillati* (= *Pselophognati*).

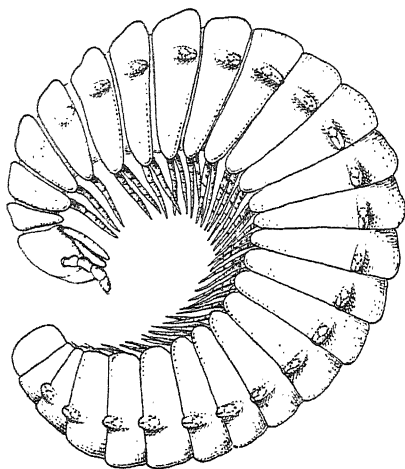


Fig. V. *Dolistenus Savii*: prima larva prossima a diventare libera (lunga nella posizione in cui è disegnata mm 1,40).

l'acron, un segment antennaire avec les antennes, un segment prémandibulaire sans appendices (il faudra étendre l'étude à autres espèces de Myriopodes et d'Insectes pour établir si le segment intercalaire doit être attribué au clypeo-labre), un segment mandibulaire avec les mandibules, un segment maxillaire avec les maxilles qui forme l'hypostome (=gnathochilarium) à l'exclusion de sa base, basilaire (ou hypostoma de Latzel), la quelle est formée par le sternum du segment labial depourvu d'appendices dans tous les Diplopodes étudiés. Au segment labial se rattache dorsalement le collum bien séparé de la tête et du tronc.

Quant au tronc, il débute par trois segments simples et fournis chacun d'une seule paire de pattes: c'est ce qu'on appelle le pretronc. A celui-ci succède le mésotronc, présentant un nombre variable de segments selon le genre et selon l'âge de l'individu considéré. Les segments du mésotronc sont simples dorsalement et doubles du côté sternal qui est muni de deux paires de pattes.

Postérieurement au mésotronc existe un segment apode appelé métatronc ou zone de prolifération. Le corps termine par le segment anal représenté par les valves latérales et une petite lame ventrale.

En vertu de ses nouvelles recherches sur le Colobognathe *Dolistenus Savii* Fanz. l'auteur confirme les résultats aux quels il était déjà parvenu en 1932 par son étude d'*Archispirostreptus gigas* et critique comme erronées les figures et l'interprétation de la segmentation de la région cephalique présentées par Robinson (1907) et Pflugfelder (1932).

## ÜBER EIN NEUES, SEHR ABWEICHENDES STADIUM IN DER POST-EMBRYONALEN ENTWICKLUNG DER PROTUREN

Von S. L. Tuxen

Bekanntlich hat Berlese, einer der beiden ersten Entdecker der systematisch sehr abweichenden Apterygotengruppe, der Proturen, auch ihre postembryonale Entwicklung aufgeklärt und ihren unter den Insekten einzig dastehenden Zug, während der postembryonalen Entwicklung weitere abdominale Glieder zuzufügen, entdeckt. Seitdem kann man in allen entomologischen Hand- und Lehrbüchern lesen, dass diese sogenannte Anamorphose, wie Berlese angibt, derartig vor sich gehe, dass die Proturen mit neun Abdominalsegmenten aus dem Ei schlüpfen, nach einer Häutung zehn Glieder aufweisen, nach einer weiteren Häutung elf, danach zwölf Glieder wie die erwachsenen, aber erst nach noch einer Häutung geschlechtsreif werden. Also vier Häutungen, von denen die drei ersten jede ein neues Segment im Abdomen hinzufügen.

Um dieses Verhältnis näher zu prüfen, habe ich während fünf Vierteljahren in einem Waldboden, wo zwei Arten von Proturen, *Acerentulus danicus* Condé und *Eosentomon armatum* Stach, vorhanden waren, jeden Monat Proben entnommen und die darin befindlichen Arthropoden mittelst Berlesetrichter herausgetrieben; und zwar habe ich jeden Monat 16 Proben entnommen, aus denen ich die Mittelzahl berechnet habe. In dieser Weise habe ich 1307 Individuen von *Acerentulus danicus* und 305 von *Eosentomon armatum* erhalten. Ich kann nun leider hier nicht diese ganze Untersuchung wiederholen<sup>1</sup>, möchte nur sagen, sie hat ergeben, dass die Entwicklung nicht aus den von Berlese angegebenen Stadien besteht, sondern fünf Jugendstadien, wovon Berlese nur drei gesehen hat, umfasst, nämlich die folgenden fünf: ein Stadium mit 9 Abdominalgliedern, das ich die Prälarve nenne, weil sie von den folgenden Stadien sehr verschieden ist, noch ein Stadium mit 9 Abdominalgliedern, ein Stadium mit 10 Abdominalgliedern, ein Stadium mit 12 Abdominalgliedern, den Maturus junior, noch ein 12-gliedriges Stadium, die Präimago, und dann also endlich das dritte 12-gliedrige Stadium, die erwachsene Protüre. Ein Stadium mit 11 Abdominalgliedern kommt aber nicht vor.

Diese ganze Entwicklung in diesem Vortrag zu beschreiben, würde nun aber zu weitläufig werden und die mir eingeräumte Zeit weit überschreiten; ich habe deshalb vorgezogen, das erste Stadium, das von den übrigen sehr abweichend gebaut ist, und dessen Entwicklung in Wirklichkeit zu weitgehenden Betrachtungen über phylogenetische und ontogenetische Fragen Anlass geben dürfte, näher zu erörtern.

Abb. 1 zeigt die zwei neun-gliedrigen Stadien von *Acerentulus danicus*, links von oben, rechts von unten. Der Unterschied ist sofort sichtbar. Der Kopf ist im ersten Stadium vorne abgerundet, weil die Mundteile wenig entwickelt sind und nicht vor dessen Vorderrand hervorragen. Die Behaarung ist sehr sparsam gegenüber der des folgenden Stadiums, besonders ventral, wo der Thorax ganz kahl ist; auch die Femora und Tibien aller Beine sind kahl. Und im Abdomen bemerkt man wesentliche Unterschiede in Form und Behaarung des 9. Segments; der proximale Streifenband und die Kämme am 8. Segment fehlen ganz im ersten Stadium; und, besonders merkwürdig, nur das erste der drei rudimentären Abdominalgliedmassen, das zweigeteilte, ist im ersten Stadium vorhanden, die zwei hinteren Paare sind nur durch ihre zwei Borsten

<sup>1</sup> Siehe meine Abhandlung in Kgl. Danske Vid. Selsk. Biol. Skr. VI 3, 1949.

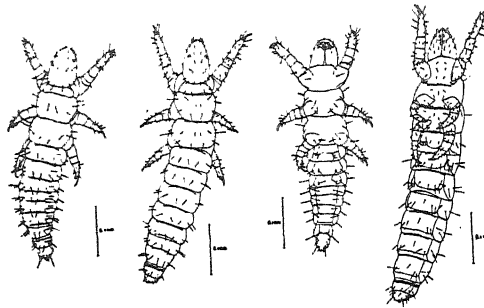


Abb. 1. *Acerentulus danicus*, Prälarve (links) und folgendes Larvenstadium, von oben und unten gesehen.

vertreten. Die Apodeme sind im ersten Stadium sehr schwach, wenn überhaupt vorhanden.

Aus alldem ist ersichtlich, dass beim ersten Stadium wichtige strukturelle Eigenschaften fehlen, die in allen übrigen Stadien vorhanden sind. Ich werde dies im Detail näher erörtern.

Abb. 2 weist den Tarsus des ersten Beinpaares, der bekanntlich die Antenne ersetzt, in den zwei ersten Stadien und beim erwachsenen Tiere auf. Der Tarsus ist von der Aussenseite und von der Innenseite abgebildet. Im zweiten neun-gliedrigen Stadium

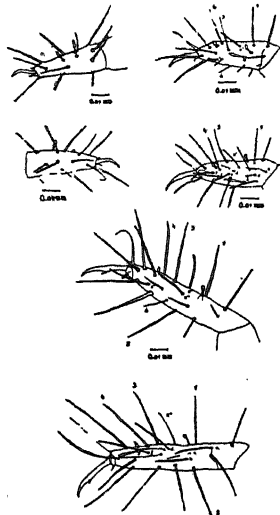


Abb. 2. *Acerentulus danicus*. Oben links Tarsus I der Prälarve von aussen und innen, rechts dasselbe, folgendes Larvenstadium, darunter das gleiche: erwachsene Protura.

und beim erwachsenen Tier ist alles gleich; der Übersichtlichkeit halber habe ich entsprechende Haare und Sensillen entsprechend bezeichnet. Aber im neuen, ersten Stadium finden wir nur zwei Sensillen — welche, kann ich nicht sagen — und weit weniger Haare.

Abb. 3. Der dritte Tarsus ist in allen Stadien gleich. Nicht aber so die Abdominalgliedmassen. Das erste Stadium ist hier ganz von der Seite gesehen; das zweite Stadium gleichfalls. Der Unterschied in der Ausbildung der zwei hinteren Gliedmassen ist deutlich wahrzunehmen. Unten dasselbe beim erwachsenen Tier.

Nun aber die Mundteile (Abb. 4). Ich habe die Köpfe eines erwachsenen Tieres und eines Tieres des zweiten Stadiums in der Mittellinie aufgeschnitten und die Seiten ausgebreitet. Links habe ich dann das Labium und die Mandibel abgezeichnet, rechts das Tentorium und die Maxille. Eine völlige Übereinstimmung ist zu beobachten. Das Aufschneiden von Köpfen vom ersten Stadium ist mir leider nicht gelungen; die geklärten Tiere zeigten aber die Verhältnisse so deutlich, besonders wo ich sie unterm Deckglas rollen konnte, dass ich die unteren Bilder habe verfertigen können, die den Kopf des ersten Stadiums von allen Seiten zeigen. Die Mundteile setzen sich nun natürlich aus denselben Teilen zusammen wie in späteren Stadien, aber alles ist sozusagen

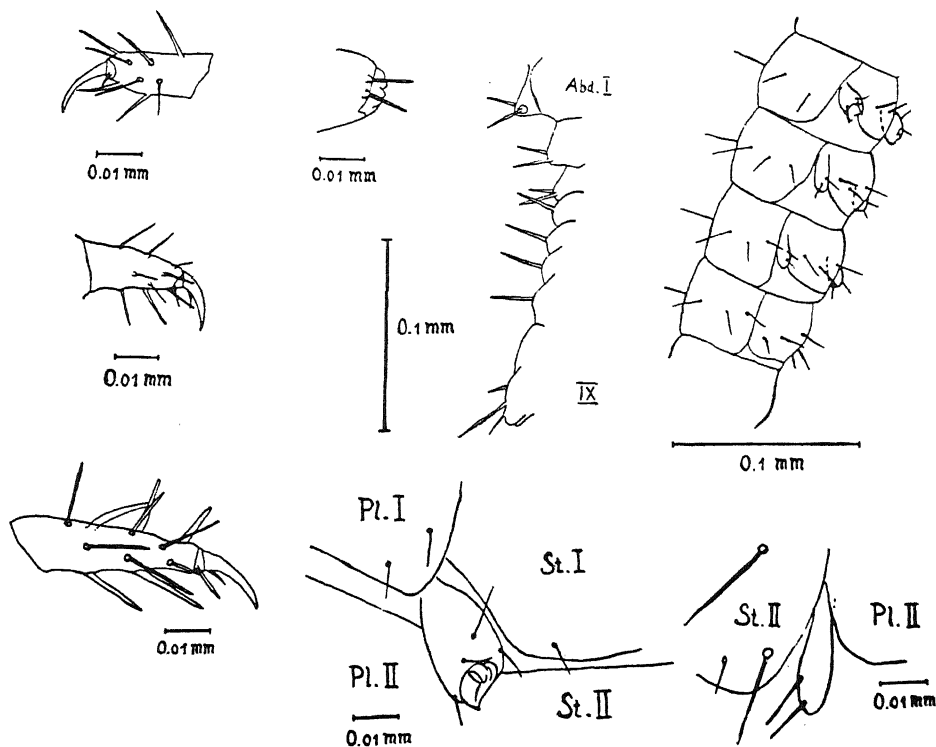


Abb. 3. *Acerentulus danicus*. Links Tarsus III der Prälarve, des folgenden Larvenstadiums und der erwachsenen Protüre. Oben in der Mitte erstes Abdominalgliedmass und Abdomen von der Seite gesehen der Prälarve, rechts des folgenden Larvenstadiums. Unten in der Mitte das erste, rechts das dritte Abdominalgliedmass der erwachsenen Protüre.

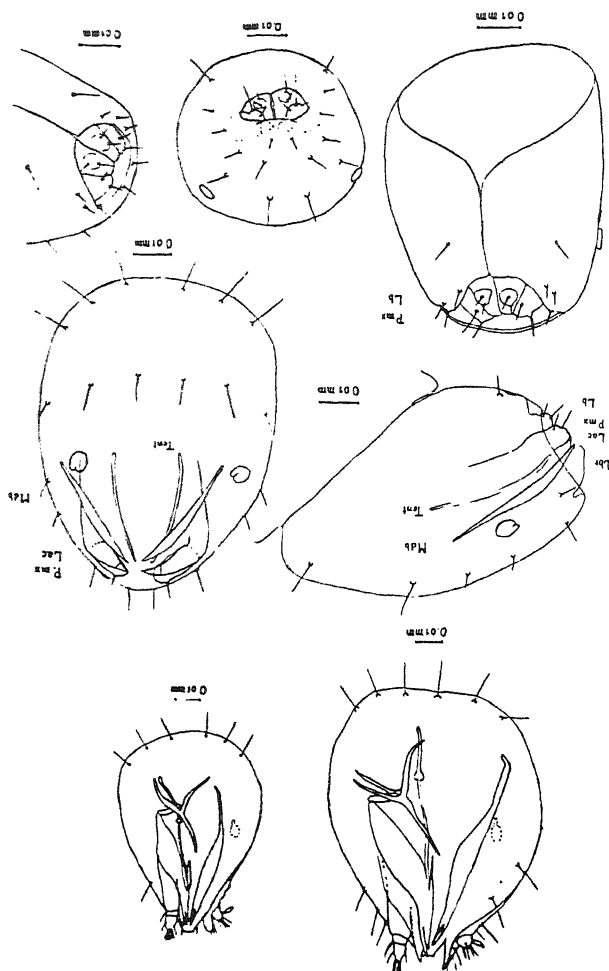


Abb. 4. *Acerentulus danicus*. Die 5 unteren Bilder zeigen den Kopf der Prälarve von der Seite, von oben, von unten, von vorne, und schräg von unten gesehen. Oben rechts der Kopf des folgenden Larvenstadiums, links der erwachsenen Protura.

unreif, unfertig, mit Ausnahme der Mandibel, die sich aus einem Stück zusammensetzt und denen der späteren Stadien ähnlich sieht. Das Tentorium besteht aber nur aus zwei schwachen Sträben; die Maxille verläuft, unsicher wie, ins Innere des Kopfes, besteht aber nach aussen aus einer, möglicherweise quergeteilten Lacinia und einem ungeteilten Taster; das Labium ist zwar ungeteilt und mit ungeteiltem Taster wie beim erwachsenen, aber mit nur einer Borste und keiner Sinnespapille. Dies alles zeigt, dass die Mundteile dieses ersten Stadiums nicht „primitiv“ gebaut sind, nicht denen eventuellen Vorfahren ähnlich, sondern einfach unfertig sind, so wie man Skizzen macht, bevor das fertige Bild entsteht. Ich habe leider Tiere dieses Stadiums nie lebend gesehen



und kann deshalb nichts vom Gebrauch dieser Mundteile, so wenig wie vom Gebrauch der „unfertigen“ Vordertarsen und Abdominalgliedmassen sagen.

Eine natürliche Frage ist nun, woher ich weiss, dass diese Tiere Vorstadien zu der Art *Acerentulus danicus* seien, und nicht ganz selbständige Arten, möglicherweise überhaupt keine Jugendstadien. Hierauf habe ich drei Antworten, wovon die eine entscheidend ist.

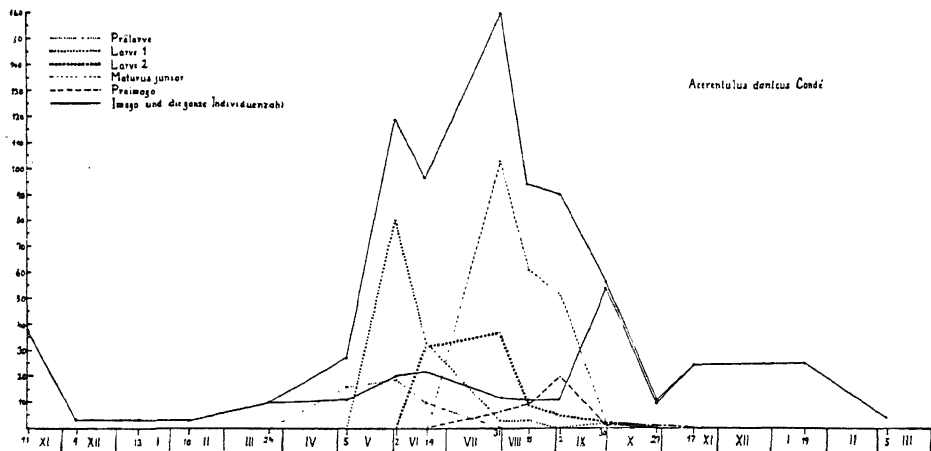


Abb. 5. *Acerentulus danicus*. Die Aufeinanderfolge der verschiedenen Stadien in den Proben. Ordinaten: Anzahl von Individuen pro 1/100 m<sup>2</sup> Bodenschicht.

Wie gesagt habe ich allmonatlich an besagter Stelle Proben entnommen; Sie sehen in der Kurve Abb. 5 die jedesmalige Anzahl von *Acerentulus danicus* in jedem der fünf Jugendstadien sowie im erwachsenen Stadium. Und Sie werden sehen, dass die Stadien hübsch auf einander folgen, erst das was ich die Prälarve nenne, die Anfang Mai in den Proben erscheint und im Juli nicht mehr vorhanden ist; dann, was hier belanglos ist, die übrigen Stadien. Also unter der Voraussetzung, sie seien die ersten Jugendstadien von *Acerentulus danicus*, ergibt sich ein schöner zeitlicher Zusammenhang. — Abb. 6 aber entscheidet die Sache.

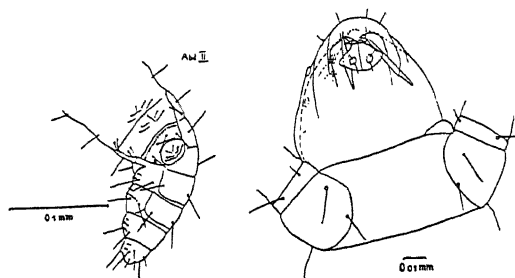


Abb. 6. *Acerentulus danicus*. Prälarve im Hautwechsel begriffen.

Bekanntlich entsteht bei jeder Häutung unter den Arthropoden die neue Haut innerhalb der ersten, und zwar gewöhnlich eine geraume Zeit bevor die Häutung stattfindet. In den Proturen kann man, besonders an den Extremitäten des Körpers, Kopf und Hinterende sowie an den Spitzen der Gliedmassen, diese neue Haut oft innerhalb der alten liegend finden; und klärt man die Tiere in irgendeiner Weise, kann man sie ebenso klar wie die äussere Haut sehen. Ich habe nun zwischen fast allen 6 Stadien im Leben der Proturen solche häutende Individuen gefunden, was der von mir anfangs gegebenen Reihenfolge der Stadien eine absolute Sicherheit verleiht; in dieser Beziehung ist aber nur die Häutung von der Prälarve zur ersten Larve zu erwähnen; und die zeigt Abb. 6. Sehr deutlich zeichnen sich der proximale Streifenband und die Kämme am 8. Abdominalsegment aus, sowie die weit reichere Beborstung des späteren Stadiums; die alte Haut ist eindeutig die einer Prälarve, obgleich sie bei der Präparation leider um  $90^\circ$  gegenüber der des neuen Stadiums gedreht ist. Auch im Kopfe zeigen sich, zwar undeutlich, die wohl entwickelten Kiefer- und Lippentaster des neuen Stadiums innerhalb des alten Kopfes mit den „unfertigen“ Mundteilen. Es ist somit sicher, dass eine Prälarve in der postembryonalen Entwicklung von *Acerentulus danicus* vorkommt.

Es ist aber wahrscheinlich, dass sie in der Entwicklung aller Proturen vorkommt. Ich habe nämlich auch ein solches Stadium von der anderen in den Proben vorkommenden Proturenart, *Eosentomon armatum*, gefunden, obgleich viel seltener; nur zwei Exemplare habe ich gesehen.

Abb. 7 zeigt dieses Stadium. Sie werden erst die prinzipielle Übereinstimmung mit der Prälarve von *Acerentulus danicus* feststellen, danach aber auch deutliche Unterschiede. Z. B. sind alle drei Abdominalgliedmassen vorhanden und ähnlich wie beim erwachsenen, d. h. zweigeteilt, ausgebildet. Auch fehlen die vielen kleinen Dornenreihen, die dorsal am Abdomen von *Acerentulus* vorhanden waren, und sind durch wenige zerstreute Dornen am 8. Segment ersetzt. Besonders merkwürdig ist das Fehlen einer Klaue am Vordertarsus; dies Verhältnis ist aber an allen 4 Vordertarsen gleich. Sie werden das Stadium im Detail in der Abb. 8 sehen. Ich hebe besonders die Mundteile hervor, die sich von denen der Prälarve von *Acerentulus* unterscheiden, jedoch auch nicht denen der späteren Stadien von *Eosentomon* ähnlich sehen. Am Labium fehlt der Taster, wofür wir aber zwei grosse Borsten und eine kleine finden; die Maxille zeigt grössere Ähnlichkeiten, die Lacinia ist aber längsgeteilt.

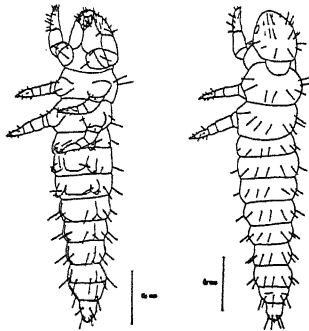


Abb. 7. *Eosentomon armatum*. Prälarve von unten und oben gesehen.

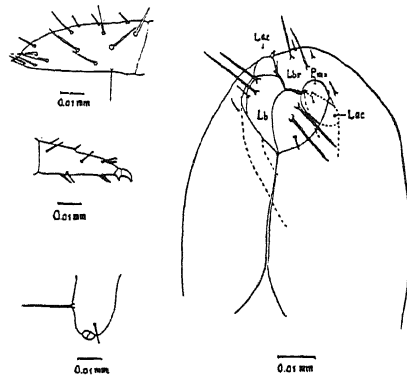


Abb. 8. *Eosentomon armatum*.  
Prälarve. Links von oben: Tarsus I und  
III und erstes Abdominalgliedmass,  
rechts der Kopf von unten gesehen.

Und endlich ist die besondere Merkwürdigkeit hervorzuheben, dass das Tracheensystem, das bekanntlich *Eosentomon* vor den Acerentomiden auszeichnet, in der Prälarve fehlt; ich habe weder Stigmen noch Tracheensystem in den zwei mir vorliegenden Individuen beobachten können. Und wieder muss ich generalisierend feststellen, dass diese Prälarven nicht das Bild eventueller Vorfahren mit „primitiven“ Merkmalen aufweisen; das Tracheensystem muss beim erwachsenen *Eosentomon* rudimentär vorhanden sein, fehlt aber in der Prälarve; die zwei hinteren Fusstümmel vom erwachsenen *Acerentulus* werden auch als rudimentäre Abdominalgliedmassen angesprochen, fehlen aber in der Prälarve; die Mundteile sind auch nicht in der Prälarve primitiver ausgebildet, sondern nur unfertig, mehr skizzenmässig. Eine Erklärung dieses Phänomenes wage ich gegenwärtig nicht zu geben; ehe dies geschehen kann, müsste wohl zuerst die Kenntnis der embryonalen Entwicklung der Proturen eine tiefere sein; bis heute ist dies Gebiet noch zu ungeklärt.

## AN AERODYNAMIC SENSE ORGAN IN LOCUSTS

By *Torkel Weis-Fogh*

Research concerning the physiology of insect flight is going on in Professor August Krogh's private laboratory (address: Søbrennen 24, Gentofte, Denmark). A grant received from the Anti-Locust Research Centre, London, under the direction of Dr.

The first problem was how to make insects fly. Fraenkel (1932) found that many insects when suspended start flying when the tarsi lose contact with the ground. So do locusts, but the locusts very soon stop flying. Other investigators (Fraenkel, Hollick, and Kennedy) have found that a current of air stimulates flight. As far as *Muscina stabulans* is concerned, Hollick found that this is due to stimulation of certain parts of the antennae. I have found, that suspended locusts (*Schistocerca gregaria* (Forsk.) and *Locusta migratoria* L.) fly for long periods, half an hour or more, if certain sensory hairs located on the frons and the vertex are stimulated by means of a jet of air. Stimulation of other parts of the body has no effect. Thus one can make a locust perform stationary flight in the following way: the locust is suspended by means of a small metal bar fastened to the pronotum (see fig. 3). A jet of air from a pointed glass tube is directed against the upper part of the frons. The locust immediately starts flying and the front legs are drawn up. Flight stops when the air current stops and starts again on fresh stimulation by the air jet. Under these conditions sustained flight is best performed in complete darkness or with a red bulb as the only illumination, the animals being very sensitive to ordinary light. A flash of light may serve as a "whip" to start flight.

This reaction can be used in several ways. Thus we have constructed a respiration chamber in which air is circulated by a pump and delivered as a jet of air against the animal's head. In a total volume of one litre or less, flight can be maintained and the metabolic rate and respiratory quotient measured by gas analysis. During sustained flight locusts mainly utilize fats, the R.Q. being 0.73–75.

The areas sensitive to air currents have been localized by covering them with cellulose paint. The sensitive area has nothing to do with the antennae in these insects. When the area is covered *in toto*, the animals do not react in the manner mentioned, and sustained flight does not occur. Fig. 1 shows the chaetotaxis of the upper, sensitive part of the head capsule. In the very place where the sensory system must be situated according to the covering experiments some very distinct patches or beds of sensory hairs are seen. There are five pairs of beds connected with each other, situated partly on the vertex and partly in a line just in front of the compound eyes. The sensory hairs are long and of normal trichoid type, with a basal plate situated on a thin flexible membrane of articulation.

The hairs are innervated by a pair of very distinct nerves (fig. 2), emerging from the tritocerebrum. They are named *N. tegumentarii* (Hanström 1928). Jawlowsky (1936) has shown that they do not branch in the cerebrum (*Coleoptera*), but that they run directly to the oesophageal connectives. Ehnborn (1948) is the only investigator who has studied the end organs of these nerves (in neuropteroid insects) and he found that they innervate Eltringham's organ. But the function of this organ and the corresponding hair patches in locusts has not hitherto been studied. The nerves in locusts innervate the wind-sensitive area only.

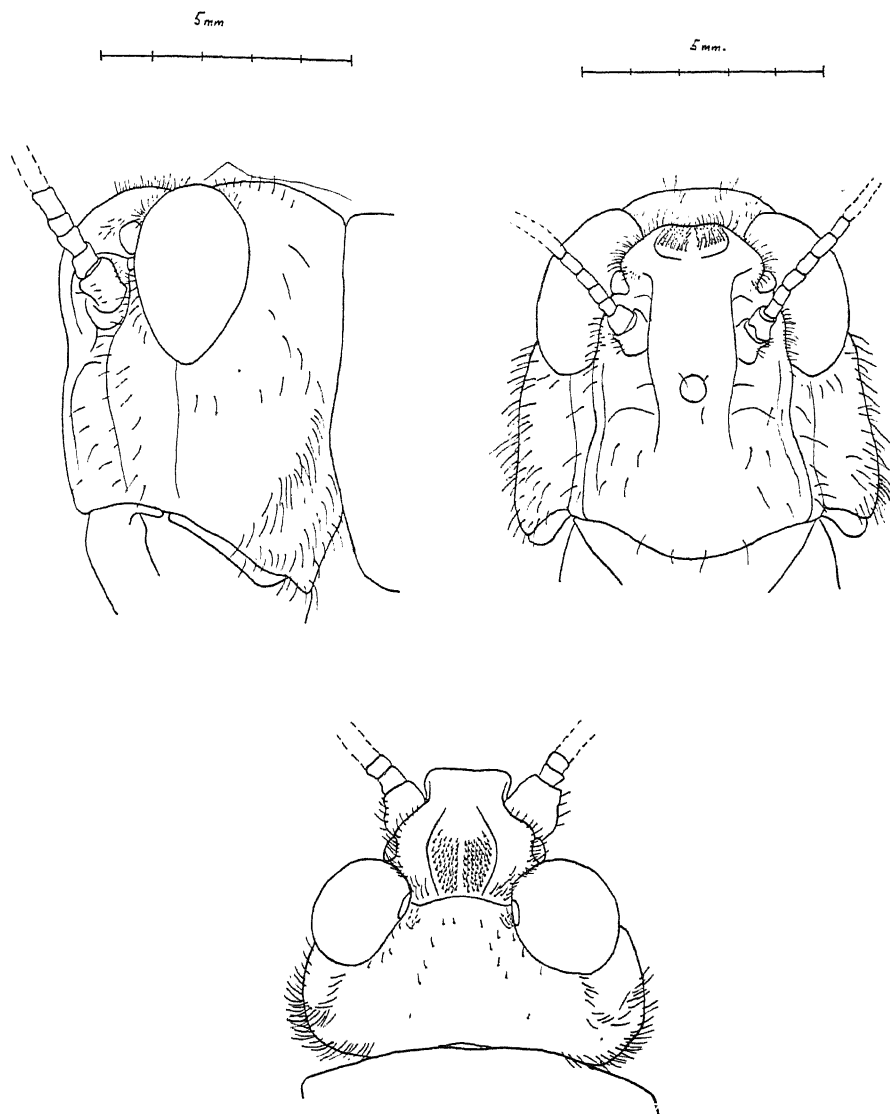


Fig. 1. *Schistocerca gregaria*. Chaetotaxis of the upper part of the head capsule. Lateral, frontal, and dorsal view.

When the air current blows past the sensory hairs, they bend basally, the angle depending on the wind velocity. But they do not vibrate as is normally the case with hairs in a streaming fluid, and as seen on the prothorax and other parts of the body. Thus the sensitive area can be characterized both by innervation and by hair structure (damping mechanism).

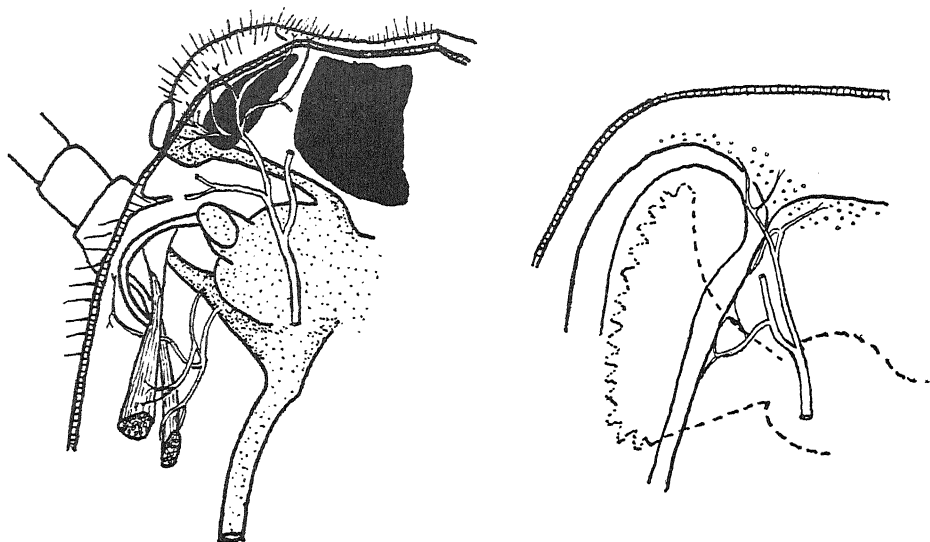


Fig. 2. *Schistocerca gregaria*. The branches of the left *Nervus tegumentarius*. Right: frontal section just behind the compound eyes. Left: frontal section just in front of the compound eyes. The brain and the main nerves are dotted, the main air sacs are dark.

The function of this sensory system is not restricted to the mere stimulation of flight. It also functions as a sensory organ regulating flight movements. A closer examination of this regulation has been made. Fig. 3 shows a turning apparatus, the animal and the air jet tube being placed on the same frame. The frame is suspended on a single pointed steel pin and turns very easily. The rubber tube for the air current serves as a torsion string, bringing the frame back to zero. The air jet is directed towards the centre, while the animal is turned a little to the left or to the right of the air jet ( $5^{\circ}$ — $15^{\circ}$ ). If the animal moves the wings symmetrically and thus produces symmetrical forces on the two sides, the frame does not turn. If on the other hand the right wings move more efficiently than the left, the animal and the frame will turn to the left.

Several experiments show that *Schistocerca* turns up into the air current, that is to say that the animals turn to the left when the air current is placed a little to the left. In other words, when the two sides of the head or the organ are stimulated unsymmetrically the animal moves the wings in an unsymmetrical way, and these unsymmetrical movements turn the animal so as to establish a symmetrical stimulation.

When an insect flies in stationary or uniformly moving air, it creates the air current itself, the direction of the current being always exactly opposite the direction of flight. When such an insect flies in a straight line and then suddenly, by chance, turns the body axis to the left, the air current comes in a little to the right of the animal, and it will then turn to the right and so maintain the old direction of flight. Thus the organ functions as a stabiliser, regulating flight in the horizontal plane. Covering the lateral hair beds in front of the eyes inhibits regulation, uncovering results in normal regulation.

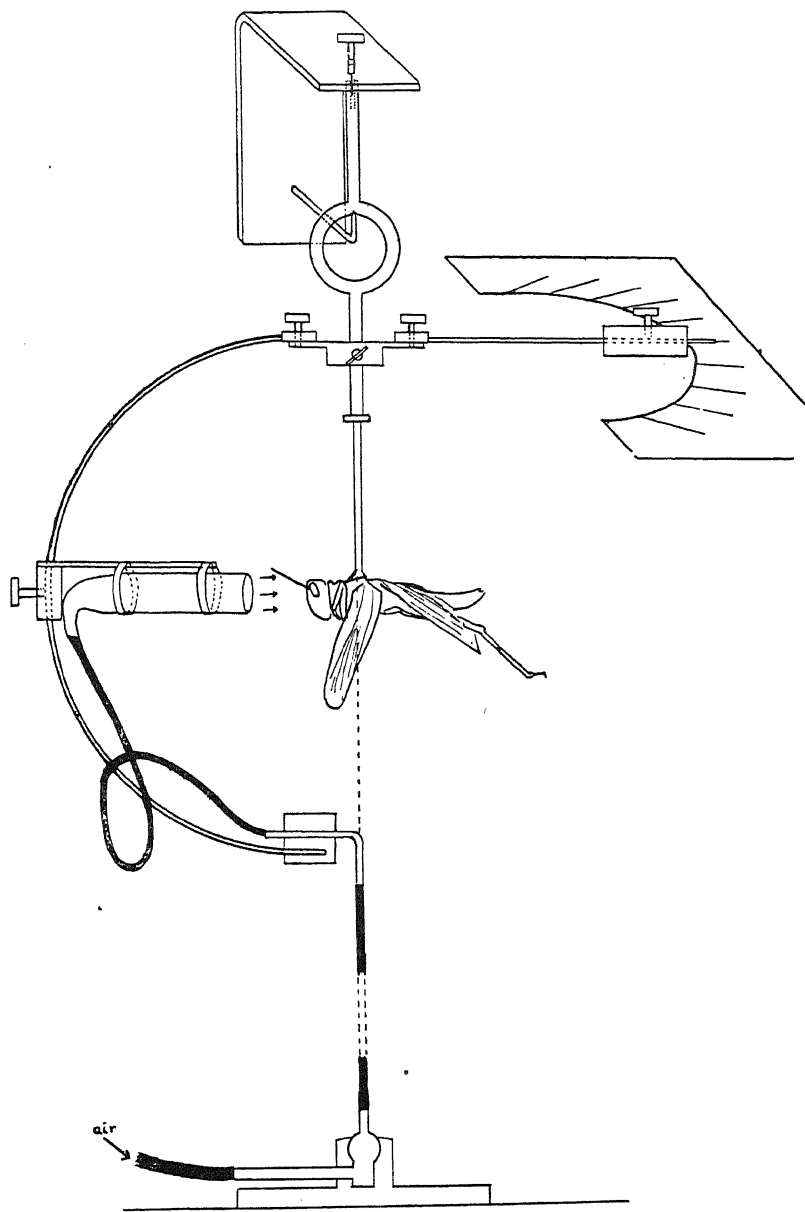


Fig. 3. Turning apparatus. The fore legs of the suspended locust are held in flight position.

Studies on insect flight have to be performed under conditions corresponding more closely to the natural. So we constructed an open wind tunnel, delivering a perfectly uniform air current of 15 cm. diameter, the velocity of which can be regulated and measured quickly. The insect is suspended in a pendulum in front of the tunnel. When flight starts the pendulum moves forward, and then the wind speed is increased until the wind pressure forces the animal back to the original position. In this way we can study the flight of insects under nearly normal conditions, measuring the flying speed, wing beat frequency (stroboscope), amplitude, the torsion of the wings in different positions, the course of the wings through the air, the lifting force, and so on.

It is impossible, however, to study the turning reactions in the wind tunnel, but I made some experiments on vertical regulation, i.e. regulation in the vertical plane, in the wind tunnel, using a special arrangement which makes it possible to vary the direction of that part of the air current reaching the sensory hairs. Neither the lift nor the speed of an animal seems to be affected, however. So it is still uncertain if the locusts have any vertical regulation, but it is in fact most probable: flight over long distances in high altitudes would be almost impossible in animals lacking any sort of static organs.

*Discussion.* J. S. Kennedy, Cambridge, England: What is the size of the angular acceleration necessary for the turning reaction? T. W.-F.: Nothing is known at present, but the smallest necessary deviation between air current and body axis in this apparatus amounts to  $5^\circ$ .—Both speakers agreed that the organ functions as static organ analogous to the vertebrate labyrinth, but this function has nothing to do with the maintainance of a straight course over *long* distances, often seen in migrating swarms.

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## ARTIFICIALLY INDUCED EGG-LAYING IN VIRGIN ANTS

By Derek Wragge Morley

It has been known for some years that if virgin queen ants kept in captivity are stripped of their wings, their behaviour undergoes a marked change. The normal winged virgin queen ant is restless and constantly seeks to escape from the nest during the brief period which usually elapses before her marriage flight. When she is placed in an observation nest in the laboratory with a group of queenless workers she in no manner serves the function of a queen mother to her nest mates, nor do they behave as if they regarded her as such either by paying her special attention or by their own behaviour. The absence of a queen in the ant colony leads to a marked change from the normal in the behaviour of the remaining workers: the colony soon becomes unthrifty and the mechanism of the division of labour does not work smoothly; fewer tasks are undertaken and there seems to be a general lack of incentive. The expectation of life of the individual worker is markedly lowered.

The replacement of the dead queen or queens by a winged virgin queen ant brings no alteration in these phenomena, but replacement by the same virgin queen twenty-four hours after her artificial de-alation in the laboratory often has a marked effect. The colony is temporarily rejuvenated and in many cases haploid (i.e. unfertilised) eggs appear. These, if they develop, turn into males. In many of the records of such artificial adoptions it is unfortunately not certain if these eggs were in fact laid by the virgin queen ants, or by their worker nestmates. (See Haskins and Enzmann 1945 New York Entom. Soc. 53 263—277; Goetsch and Käthner 1937. Zeitschr. Morph. Oekol. 33 201—260 et al.) In the author's experience such adoptions sometimes lead to a temporary increase in fertility of some of the workers who commence to lay eggs, even though the virgin queen remains unproductive.

It is difficult to control the behaviour conditions of such experiments: Haskins and Enzmann working with *Aphaenogaster fulva* and *Aphaenogaster lamellidens*, experienced some difficulty in obtaining peaceful adoptions of such de-alated queens. The author on the other hand has not experienced any difficulty of the kind in similar adoption experiments with *Formica fusca*, *Myrmica*, (several species) and *Acanthomyops* (several species). Much of the success or failure of such experiments seems to depend on a long familiarity in handling the species of ants which are to be used and the, often almost intuitive, assessment of the delicate and in many cases not consciously definable balance of factors which make up the ant behaviour pattern. (After many years of handling ants almost daily I should find it difficult to explain adequately the precise reasons for many of the simplest operations which are undertaken in the course of their normal day to day care.)

This rejuvenation of the ant colony by the introduction of de-alate virgin queens is in most cases only temporary. If eggs are produced for some time and only males develop the same conditions of unthriftiness and greater lethargy tend to recur on the escape or death of these useless offspring. In such cases the pseudo-queen may be neglected, but is rarely killed, usually outliving its worker nest-mates. On the other hand, a colony which remains entirely unproductive after such an adoption seems in a few cases to thrive better for periods of from 8—9 months than other similar colonies in which the useless males have been produced.

It should be emphasised here that the initial size of the queenless colony when isolated may have some importance in interpreting such results. Five isolated *Formica rufa* workers lived without any apparent impairment of health for nearly a year until accidentally killed. Similar queen-less colonies of larger number rarely, however, survive more than a few months. Two or three isolated *Formica fusca* workers may live for well over the year in captivity, although in such cases great care must be taken before adding to their number or returning them to their original fertile colony.



There is thus ample experimental evidence that the haploid male ant may be reared in ant colonies in which all forms — queens and workers, are unfertilised. There is considerable evidence that behaviour influences of a psycho-somatic kind play a considerable part in such cases.

No worker has yet been reared in captivity by the technique described above, although in two cases Haskins' pupae contained apparently perfect worker-form imagos which never hatched. The experiments of Reichenbach and Crawley were unfortunately insufficiently controlled. (In this I agree with Goetsch *loc. cit.*), although it does seem probable that such an event does sometimes occur. That is, that eggs laid by unfertilised workers and queens do sometimes develop into the diploid worker form.

It should be emphasised that the only queens which can safely be regarded as *virgin* are those reared in captivity under laboratory conditions. Winged queens taken in the field may have been fertilised in the nest. (16 of Haskins and Enzmann's "infertile females" were collected from wild colonies.)

In order to facilitate experiments which are being undertaken on the behaviour—inheritance relationships of ants (See "The investigation into the learning ability of ants" VIII Int. Cong. Ent. 1948) the author commenced a series of experiments to a) increase the number of sexual generations obtainable from the ants each year, and b) to stimulate egg-production in both virgin queens and workers. The former experiments have to date achieved an important, but partial success, several generations, (queen to queen) being obtained each year in several species; but it is the latter experiments which are of interest here.

Following up the apparent importance of physical stimulation of behaviour and behaviour stimulation of physiological factors indicated by the de-alation experiments (i.e. the somatic-psycho-somatic interplay), an additional routine was incorporated in the treatment of some virgin queens of *Formica fusca*. At first four and later eight more *F. fusca* virgin queens were treated as follows:—After de-alation and a short period of isolation the ants were carefully pierced through the vagina with a thin glass tube. This was done while they were gently but firmly held in the experimenter's fingers; they were not anaesthetised. In some, but not all, of the cases a fluid was injected through the rod. This was of a somewhat viscous consistency, but contained no sperm, only sugar and water.

After these events the queens were placed back into isolation or in pairs (the original four *fusca* queens were kept singly at this stage) for a period of two or three days when in all except two of the cases they were placed in nests containing from two to eighteen workers. In the latter case two females were placed in the nest together. Special feeding was given to these colonies and heat and humidity were as far as possible controlled; doses of exposure to sunlight were also given. Eventually, after nearly three weeks, the two queens in the largest colony showed signs of abdominal fattening and soon afterwards one of the other two queens originally treated did the same. None of the four untreated control queens showed any such development. (Later, after continued sterility, two were successfully treated.) Soon afterwards the three queens commenced to lay eggs, although the fourth one died, with no apparent sign of egg-development.

Although there was considerable wastage owing to accidental factors in these first experiments, several eggs developed into larvae from later batches laid by the same queens. These continued a normal developmental history and are diploid, developing into workers and queens. Since these initial experiments further treatments have been made, but owing to the difficulties of controlling all the many possible factors involved it is not yet certain what mechanisms are at work. In nine cases using *Formica fusca* females success has been achieved, out of a possible dozen cases treated in these various ways. Experiments are continuing, using also *Acanthomyops flavus* and *niger* and *Myrmica* sp. There seems no reason to suppose that the scale of the success will not continue, although owing to the accessory nature of the original experiments which were undertaken solely as a technical aid to a much larger programme of work, the author frankly confesses that he is still in ignorance as to which precisely are the important elements of the technique which causes this unusual reproduction. It seems probable that mechanical stimulus and nervous shock may be in part causatory, especially in view of the experiments of Mackenson on bees. (It is necessary to reiterate however the vast differences in sex-determination mechanisms that appear to occur between bees and ants, as well as wide behaviour differences. Mackenson's observations are of interest in the present connection although they help us very little.) Some cytological examin-

ation is also being undertaken and it is hoped that another collaborator will shortly be able to tackle the problem from the embryological side.

Naturally these results are of great importance in the furthering of genetic work on the ants, since there appears to be no sterility of offspring and a most complete form of inbreeding is possible enabling quick sorting out and concentration of inherited factors.

Experiments are also being undertaken to enable a similar constancy of reproduction (even if only of haploid male forms) to be obtained from workers selected for other genetic reasons. Here there is some indication that injection of glandular secretions may aid success.

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## SECTION V

## THE CONTROL OF THE MOSQUITO BLIGHT ON THE CACAO ON JAVA

By J. G. Betrem

The mosquito bug of the tea (*Helopeltis* spec. div.) is a well known pest and much has been published about it, in the Netherlands East Indies as well as elsewhere. The most extensive publication is that by Dr S. Leefmans (1916).

About the mosquito-blight of the cacao, however, on which plant it is at least as noxious as on the tea, not so much has been published, though almost fifty years ago Dr L. Zehntner wrote some articles on this topic (1900—1905). Prof. Dr W. Roepke published several notes about these bugs (1908, 1918). No further work was done until in 1930 Dr J. K. de Jong renewed the study of this insect both on tea and cacao. This research concerning cacao is continued by the author until the occupation by the Japanese (1936—1941).

On Java two species are very common on cacao, viz. *Helopeltis antonii* Sign., the red mosquito-bug and *Helopeltis theivora* Waterh., the green mosquito-bug. The first causes the more serious damage, because it occurs in much greater numbers than the second. It attacks the cacao-pod in all its stages of development as well as the young shoots. The last mentioned damage is the most dangerous, because the shoots die down, if many bugs have punctured them. The tree then has to form a new flush and sometimes even a third one, if the second is also destroyed. This weakens the tree, and its reserves become exhausted, so that not only does the yield diminish, but, in heavy attacks, nearly no pods can ripen, they drop before being half-grown. With each puncture the saliva causes the death of a small piece of plant tissue which blackens afterwards. The *Helopeltis* has many foodplants.

First we will deal with direct control measures. The oldest is hand-picking of the bugs. Until the year 1933 this was the only possible method of control. Although it can give some results, if used on small plants e.g. on nurseries, it fails if applied on larger trees. The percentage which can be picked, is always so small, that in case of young growing populations, there is almost no effect on the growth of the latter and in case of large populations only their density is somewhat diminished, so that it is only the death rate which becomes temporarily lower. Field experiments have confirmed these conclusions. If we compare the objects: handpicking four times, two times or one time each month, we find that in the average on each day of catching there are picked 106.6, 128.7, 115.7 bugs (young and old). Analysis of variance shows that there exists no significant difference between the objects. We come to the same results by comparing the damage to the shoots. Although the number of black spots found on the pods was significantly higher in the objects without handpicking, this difference had no effect on the yield at all (Betrem 1937).

The control of *Helopeltis* by insecticides has been worked out only rather recently, because until lately no good contact insecticides were known. The first experiments by de Jong with dusturan failed because the powder used proved to be no longer active. Almost simultaneously experiments were begun with derris (akar tuba) in tea and in cacao culture. These showed so great a success that especially in the case of

cacao, they not only were continued until the occupation, but even the estates started to use this insecticide on a large scale.

Of the results of the experiments I will only mention the most important ones: (1) Dusting proves to be three to four times superior to spraying. (2) By dusting every two weeks with a powder containing  $\frac{3}{4}$  % rotenon during the time the pest is above its damage point<sup>1</sup> the mosquito-bug can be controlled. (3) The derrispowder, however, has to fulfill the following qualifications: a. The rotenon content of the powder (before mixing with a carrier) must not be below 4 %, rather it must be higher. b. The unmixed powder has to be of uniform composition, both in regard to the size of the particles and to rotenon content. c. At least as much as 90 % of the particles must pass through a sieve of 200 mesh. (4) Fine talc powder and fine vulcanic ash of the Merapi (sieved through a sieve of 200 mesh) have been used as carriers. In field experiments these carriers both proved equally good. The physical properties are, however, very different. Under the microscope the derris particles in the talc mixtures are covered by very fine talc particles; this is not the case with the ash carrier; there the derris particles stay bare. (5) The most economical control of the damage was obtained, if the dusting was begun, when by hand picking during five minutes on each tree 0.8 winged bugs in the average were caught. The number of the nymphs appeared to be unimportant.

The possibilities of the control of mosquito blight by indirect measures are many, but none of them as yet has been sufficiently effective.

Although a parasite of the *Helopeltis* nymphs (*Euphorus helopeltidis* Ferr.) is known, this wasp never appears in such numbers that it can control the bug adequately.

Control of the mosquito bug by the black cacao ant (*Dolichoderus bituberculatus* Mayr) has long been advised. This ant visits by preference the cacao mealy bug (*Pseudococcus tayabanus* Cock. = *Pseudococcus lilacinus* auct. nec Cock.). Dr P. v. d. Goot (1916, 1917) has demonstrated that this mealy bug can only prosper, if the ants are present. The presence of these ants should, however, disturb the *Helopeltis*. Recent research has shown that, although this is true, only in exceptional cases can the bug be partly controlled by the ants.

The observation of the planters, that, where black ants and mealy bugs occur, almost no mosquito bugs are found, is certainly correct. Experiments made by the author later on continued by Dr Ph. Levert and Dr G. Giesberger, show that pods on which mealy bugs have settled, are avoided by the winged bugs. If the imagines are given the choice between pods of trees on which ants and mealy bugs are present and pods of trees on which these are not living, more than 90 % of the punctures of *Helopeltis*, after some time, will be found on the pods without mealy bug. So we can conclude that the physiological condition of the pods themselves is the reason why the winged bugs avoid the ones on which the mealy bugs could prosper.

Only in case the condition of the pods is suitable to both the mosquito bugs and the mealy bugs, will the ants more or less control the *Helopeltis*. Field experiments have confirmed this fact. The control by the ants, however, has not much influence, at most the *Helopeltis* population proved to be diminished to 75 %. The planters often tried to increase the population of black ants by putting in the plantations artificial nests of old leaves in which the ants prefer to live. This was not, however, successful,

<sup>1</sup> The damage point is reached, when the natural power of recovery of the plant is insufficient to restore the damage caused by an insect population. (compare: Betrem, Archief v. d. Koffiecultuur 10, p. 188, 1936).

because the ant can only prosper, if the mealy bug is abundant and this depends on special physiological conditions of the cacao tree (Betrem 1946).

Dr J. K. de Jong had previously shown that the multiplication of the mosquito bug on the tea could also be dependent upon the chemical constitution of the plant. He showed that the number of eggs laid by bugs fed on twigs standing in a sugar solution was distinctly smaller than if they were feeding on normal twigs. Possibly the proportion of nitrogen compounds to carbohydrates, N/C quotient, is of great importance. For the forming of eggs a large quantity of albumen is necessary. By presence of too much carbohydrates the forming of eggs is not possible, because the proper ratio between both constituents fails. Many Homoptera, however, can alter the composition of the food taken up, by excretion of the surplus of sugar as honey dew. This is probable the reason why the mealy bugs prefer another physiological condition of the plant than the mosquito bug. In connection with the above-mentioned hypothesis Dr G. Giesbergen has analysed the upper layer of many pods in regard to sugar and nitrogen. Not any connection between the chemical composition and preference by the bugs for the pods could be found. It is, however, possible that the analysis was not complete enough, for Andrews showed that also the kali and phosphor contents could be of importance in this case. Experiments to alter the preference and extent of damage in the cacao by artificial manure has not given any distinct result up until the present time. None of the fields used for these experiments, however, showed any deficiency of kali.

The climate is one of the most important factors that regulate the size of the mosquito bug population. If the East Monsoon is very dry the population vanishes almost completely. Experiments with pods showed that the bugs then died simultaneously in the laboratory and in the field.

The water content appeared to become lower and lower. The mealy bugs on the contrary multiply abundantly in the dry season and produce very much honeydew. With the beginning of the West Monsoon the mosquito bugs reappear. The population grows slowly and mostly becomes harmful for the plantations in February. If, however, the dry monsoon is relatively wet, so that a population of comparatively large size can survive, the damage point can be reached as early as December. To study separately the influence of the climatic factors the bugs were reared under different constant conditions of temperature and humidity ( $11^{\circ}$ — $35^{\circ}$  C and 70 %—100 % rel. hum.), while the food used was the same. Although interesting results were obtained, influences of these factors on the mortality percentages and the number of the eggs laid were not of such importance that they could be the direct causes of the large differences in the size of the populations. The influences of these climatic factors on the bugs can only be through the plant; therefore the physiological condition of the cacao must be of the greatest importance.

In conclusion we can say: 1. The direct control of the mosquito-bug in the cacao with a derrispowder mixture containing  $\frac{3}{4}$  % rotenon shows very good results. 2. A sufficient indirect control attacking the real cause of the pest has not yet been found, but there are indications that in the future this more logical control will be possible.

Because the research mentioned was done before the war, the new contact insecticides e.g. DDT and gammexane were not used. It is, however, not very probable that these can be used in the cacao culture in the future. Cacao is pollinated, as the latest research in Trinidad and Africa has demonstrated, by a very small fly (*Forcipomyia*), the larvae

of which probably live in the litter under the trees. If we were to dust with the above mentioned new insecticides most of these chemicals would accumulate under the trees because of their stability and resistance against climatic influences; therefore the possibility is great that the larvae of this very important pollinator would be killed and insufficient setting of fruits would result.

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## LES ENNEMIS DU DORYPHORE (*Leptinotarsa decemlineata* Say) ET LEUR CAPACITÉ DESTRUCTIVE

Par M. Boczkowska

Dans mes notes précédentes (2a, 2b,) j'ai indiqué l'importance économique de certains prédateurs du Doryphore dans le Sud-Est de la France. En 1947 et en 1948 j'ai essayé de préciser dans les essais la capacité destructive de quelques Insectes et Arachnides qui peuvent s'alimenter aux dépens du Doryphore.

### INSECTES.

#### *Ordre des Dermaptères.*

*Forficula auricularia* L. Cet insecte pullulant sur les parcelles de Pomme de terre au champ d'essais à Avignon, a attiré mon attention (2a). La population du Doryphore y a été particulièrement faible, malgré le nombre élevé des oeufs déposés (jusqu'à 1000 oeufs par plante au cours de deux mois). Les plantes n'ont pas eu de dégâts sensibles, ce qui prouve qu'en France les Forficules ne sont pas nuisibles aux pommes de terre. Mes essais d'alimenter les Forficules en captivité par les larves du Doryphore ont échoué.

Au Chesnoy, en 1947, le hasard m'a permis d'observer une Forficule dévorant une larve du 2-e stade du Doryphore. En commençant par l'abdomen, la Forficule consommait progressivement toute la larve, y compris la tête et le prothorax. La disparition de la larve a été complète.

Puisque les Forficules comptent parmi les ravageurs du feuillage des pommes de terre en Angleterre, elles ont été d'abord nourries exclusivement avec ces feuilles dans mon laboratoire. Après avoir rongé des trous dans les feuilles de pomme de terre, elles ont eu une diarrhée. La maladie a cessé ensuite, quand elles se sont alimentées avec les larves du Doryphore, abandonnant les feuilles.

Les Forficules ont été même nuisibles dans le laboratoire en traversant la gaze dans les élevages du Doryphore et détruisant les larves, 1947. Elles ont pénétré dans les isolateurs de gaze sur les feuilles de pomme de terre dans notre champ d'essais en 1948.

Leur capacité destructive n'est pas très élevée. Elles consomment au maximum 10 larves du 1-er stade, ou 6 larves du 2-e stade ou 2 larves du 3-e stade par jour, certains jours elles restent sans s'alimenter.

D'après Lüstner (5) et Schwarz (7) *Forficula auricularia* est un insecte omniphage, préférant les aliments végétariens. Friedrichs (4) cite cet insecte parmi les prédateurs de *Bupalus piniarius* L., sans lui accorder une importance économique.

Il semble que pour le Doryphore *Forficula auricularia* L. n'est qu'un prédateur facultatif. Sa présence, ainsi que sa capacité destructive dépendent de l'ambiance. L'humidité élevée du champ irrigué à Avignon en 1941 peut être considérée comme une condition favorable. La présence des arbres fruitiers au champ d'essais à Saint-Genis-Laval (Rhône), par contre, serait défavorable, attirant davantage les Forficules aux fruits.

*Ordre des Neuroptères.*

*Chrysopa* sp. On voit souvent les larves s'attaquant aux oeufs et aux larves du Doryphore dans le champ. Dans mes essais, une larve néonate de *Chrysopa* a commencé de sucer une larve du 1-er stade. Au cours de leur développement les larves de *Chrysopa* consomment en moyenne 10 larves du 1-er stade, ou 6 larves du 2-e stade ou 1 larve du 3-e stade par jour. Elles arrivent même à tuer 9 larves du 3-e stade dans un seul jour, puisqu'elles ne sucent que très peu de leur contenu. Leur nombre limité au champ ne leur permet pas de jouer un rôle important dans la destruction du Doryphore.

*Ordre des Hemiptères.*

*Zicrona coerulea* L. Mentionné par Feytaud (3) et par Mayné et Breny (6), cet insecte ne semble pas jouer un rôle considérable dans la destruction du Doryphore. L'adulte mange en captivité 2—3 larves du 2-e stade ou 1 larve du 3-e stade par jour. Les nymphes suivies dès leur éclosion ne se sont jamais attaquées aux oeufs ni aux larves néonates du Doryphore. Elles se sont dévorées entre elles jusqu'à l'extinction complète.

*Ordre des Coléoptères.*

*Carabus aureus* L. Les adultes n'ont mangé les Doryphores qu'après un jeûne d'une huitaine. Ils ont préféré les larves du 3-e et du 4-e stade aux insectes parfaits. Ils ne semblent pas avoir d'importance pour la destruction du Doryphore.

*Calathus fuscipes* Goeze et *Pterostichus cupreus* L.<sup>2</sup>. Leur ration journalière a été assez régulièrement 10 larves du 2-e stade par jour. Les larves du 3-e et du 4-e stade ont été peu consommées. Ces insectes, reconnus comme nuisibles aux fruits, surtout aux fraises (1) ne peuvent pas être pris en considération.

*Coccinella septempunctata* L. Indiquée souvent comme ennemi du Doryphore, cette Coccinelle a refusé complètement d'en manger dans mes essais en 1947 et 1948. Les larves de tous les stades ainsi que les adultes mouraient sans toucher aux oeufs ni aux larves du Doryphore.

## ARACHNIDES.

*Ordre des Opilionides.*

Leur importance économique a été déjà signalée dans mes publications précédentes. (2a, 2b, 2c, 2d). Les essais en 1947 et en 1948 ont confirmé la grande capacité destructive de cet auxiliaire.

Les Opilionides préfèrent les oeufs du Doryphore à ses larves. La ration journalière moyenne a été de 25 oeufs par jour, montant à 50 oeufs après un jour de jeûne. Une espèce a été déterminée par E. Dresco (Paris) — *Phalangium cornutum* L. Les jeunes Opilionides venant d'éclore et après leur première mue ne s'attaquent ni aux oeufs ni aux larves du Doryphore. Malheureusement les Opilionides meurent facilement en captivité.

Si les conditions ambiantes sont favorables à leur développement au champ, ils peuvent freiner considérablement la multiplication du Doryphore.

*Resumé.*

Parmi les Insectes et les Arachnides étudiés, les Opilionides semblent avoir la plus grande capacité destructive. Les deux Carabides, *Calathus fuscipes* et *Pterostichus*

*cupreus*, ainsi que les Forficules, dont la capacité destructive est forte, sont en même temps considérés comme des insectes nuisibles aux autres cultures.

Contrairement à l'opinion courante, *Coccinella septempunctata* s'est révélée inoffensive vis-à-vis du Doryphore.

<sup>1</sup> Tous les essais ont été exécutés en verre couvert par de la gaze. Certaines espèces ont eu, en outre, de la terre humide au fond du bocal en verre.

<sup>2</sup> Det. J. d'Aguillar.

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## PARTICIPATION POLONAISE DANS LES RECHERCHES INTERNATIONALES SUR LE DORYPHORE EN EUROPE

Par *M. Boczkowska*

Les recherches internationales sur le Doryphore en Europe ont été commencées en 1936 par B. Trouvelot et les chercheurs allemands en France.

La Pologne n'a pas été intéressée par le Doryphore en ce moment. La menace de ce ravageur avançant vers Nord-Est de l'Europe s'est précisée en 1938 lors du VII Congrès International d'Entomologie à Berlin. Alors St. Minkiewicz (+ 1944) a été invité comme le représentant de la Pologne à la séance prochaine du Comité International de la Lutte en commun sur le Doryphore en Europe — à Wageningen en Février 1939.

Invitée par Mr. Trouvelot, Directeur de la Station Centrale de Zoologie Agricole à Versailles, j'ai entrepris en Juin 1939 les recherches sur le Doryphore et son comportement sur les variétés polonaises de Pomme de terre dans le jardin de la Station mentionnée.

Ma situation en France a été singulière : j'ai touché une bourse d'étudiante du Gouvernement Français, car les crédits polonais ont été bloqués dans l'attente de la guerre prochaine. Dès la déclaration de la guerre ma bourse a été prolongée et cela a duré jusqu'à l'Octobre 1945. La même bourse m'a été allouée au cours de mon séjour en 1945 en Angleterre. En outre, à partir du 1943 j'ai reçu un supplément du Ministère de l'Agriculture.

Cette hospitalité particulière a influencé le cours de mes travaux. J'ai été obligée de poursuivre les études écologiques régionales du Doryphore à Versailles, à Avignon, à Montpellier et à Saint-Genis-Laval (Rhône). En outre, j'ai fait des essais pour le thèse de Mr. G r i s o n. Les variétés polonaises de Pomme de terre reçues avant guerre ont dégénéré et ont été abandonnées en 1942.

Ainsi, dans mon travail double, je crois qu'un partage est justifié entre la France et la Pologne : les études écologiques régionales et les essais pour Mr. G r i s o n sont pour la France, tandis que les recherches sur les variétés polonaises ainsi que sur les parasites et les prédateurs du Doryphore sont pour la Pologne.

Je suis heureuse d'exprimer devant le VIII Congrès International d'Entomologie mes remerciements au Ministère des Affaires Etrangères et au Ministère de l'Agriculture pour la subvention reçue.<sup>1</sup>

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<sup>1</sup> Le sujet de ma communication est peut-être trop personnel. Mon cas est pourtant sans précédents. Je crois utile de l'exposer devant le Congrès, car je n'ai pas pu assister à la réunion du Comité International de la Lutte contre le Doryphore en Europe à Bruxelles en 1946.

## LE CARPOCAPSE DES POMMES

*Enarmonia pomonella* (L.), ravageur important des abricots en Valais (Suisse)

Par Paul Bovey

Dans l'ensemble de sa vaste aire de répartition, *Enarmonia pomonella* (L.) est essentiellement un ravageur des fruits des pommiers et des poiriers, que l'on peut considérer comme ses hôtes principaux. Mais, dans l'abondante littérature consacrée à cet important ennemi de nos cultures fruitières, on a maintes fois signalé la présence de sa larve dans d'autres fruits, notamment dans les fruits à noyau (pêches, abricots, prunes) et dans les noix.

En ce qui concerne les fruits à noyau, il s'agit cependant, dans la grande majorité des cas, d'attaques occasionnelles et de faible importance, sur des arbres situés à proximité de pommiers ou de poiriers infestés, attaques ayant manifestement pour origine des papillons issus de "vers" des pommes ou des poires.

Toutefois, dans deux cas bien étudiés et se rapportant à des régions très éloignées l'une de l'autre, on a constaté que l'insecte s'était en l'espace de quelques années acclimaté dans des vergers plantés exclusivement d'abricotiers ou de pruniers, qu'il s'y maintenait d'une année à l'autre en l'absence de ses hôtes principaux.

Ces deux cas concernent l'un l'Afrique du Sud où Pettey (1925) a signalé d'importants dégâts dans des vergers d'abricotiers isolés de la région de Wellington (Province du Cap), l'autre la Californie où R. H. Smith (1929, 1940) a noté des faits semblables dans des vergers de pruniers et dans des vergers d'abricotiers. Sur pruniers particulièrement, il constata des ravages affectant de 20 à 50 % de la récolte et, dès 1933, la lutte devint absolument nécessaire. L'intensité de ces ravages sur pruniers apparaît d'autant plus frappante que dans de nombreuses régions où le Carpopapse est abondant, notamment en Europe moyenne, les prunes, régulièrement attaquées par une espèce voisine, *E. funebrana* (Tr.), n'hébergent que très occasionnellement *E. pomonella* (Bovey 1937).

Dès 1943, nous avons eu l'occasion de nous intéresser à un cas qui présente de frappantes analogies avec ceux que nous venons de citer.

La culture intensive et commerciale de l'abricotier fut introduite en Suisse dès la fin du siècle dernier, dans le canton du Valais, plus précisément dans la partie de la Vallée du Rhône comprise entre Martigny et Sion. Grâce à son climat sec et chaud, très différent de celui du reste de la Suisse, cette région se révéla propice à cette culture qui y a pris actuellement un magnifique développement. D'abord localisée sur les cônes d'éboulis et de déjections au pied du versant sud de la Vallée, autour des localités de Charrat, Saxon et Riddes, elle s'est étendue dans la plaine d'alluvions du Rhône, après que les grands travaux d'assèchement en eussent permis l'intense arborisation.

Si, dès le début de sa culture en Valais, l'abricotier eut à souffrir des attaques de quelques insectes nuisibles au feuillage et au bois, parmi lesquels nous citerons la Cheimatobie (*Operophtera brumata* L.), la Tenthrede de l'abricotier (*Neurotoma nemoralis* L.), le Lecanium du Cornouiller (*Eulecanium corni* L.), divers Scolytidae (*Scolytus rugulosus* Ratz., *Xyleborus dispar* F., etc.), les fruits restèrent durant de longues années à l'abri de toute infestation.



Fig. 1. Cultures d'abricotiers des coteaux de Charrat (Valais) dans lesquelles le *Carpocapse* s'est acclimaté depuis 1930.

Mais, à partir de 1930, les arboriculteurs valaisans eurent la désagréable surprise de constater à la récolte, dans quelques cultures des coteaux où l'abricotier est en plantations pures avec la vigne comme sous-culture, un petit nombre de fruits véreux qui se révélèrent attaqués par *E. pomonella* L. Leur proportion, faible au début, augmenta assez rapidement d'année en année en même temps que les dégâts s'étendaient à l'ensemble des cultures de cette zone. Dès 1940, il ne fut pas rare d'observer dans les parties les plus infestées 15 à 30 % de fruits véreux, parfois même davantage, tandis que dans les plantations de la plaine, où l'abricotier est mêlé à de denses cultures de pommiers et de poiriers, les dégâts sont sporadiques et faibles, la proportion des fruits véreux y étant rarement supérieure à 1 %.

L'aggravation constante des ravages dans les cultures des coteaux (voir fig. 1) suscita de légitimes appréhensions dans les milieux arboricoles et, dès 1943, nous nous sommes attaché à l'étude de ce problème en vue de la mise au point d'une méthode efficace de lutte.

#### *Cycle biologique et comportement de l'insecte sur l'abricotier.*

Dans le Valais central, les premiers papillons du *Carpocapse* apparaissent durant la seconde quinzaine de mai — dès la mi-mai lorsque le printemps est précoce — à un moment où les abricots (var. Luizet) mesurent environ 2 à 2½ cm. de long.

En raison de l'aspect duveteux de ces fruits, les papillons pondent exclusivement leurs oeufs sur les feuilles, de préférence à la face inférieure (fig. 3), et sur les rameaux lisses de l'année précédente qui portent les fruits, toujours à proximité de ces derniers (fig. 2). Les jeunes chenilles qui éclosent en général au bout de 8—10



*Fig. 2. Oeuf pondu sur rameau, à proximité d'un groupe de fruits. — (Gr. environ 3 fois.)*

jours — la période d'incubation pouvant se prolonger jusqu'à 18 à 20 jours (1948) — pénètrent le plus souvent au point de contact de deux fruits (fig. 4), parfois dans la dépression pédonculaire ou dans le sillon, rarement ailleurs. Les premières perforations s'observent fin mai, début de juin, et, le développement larvaire durant environ un mois, les premières chenilles quittent les fruits fin juin — début de juillet. Mais comme les abricots sont récoltés en Valais durant la seconde quinzaine de juillet, seules parviennent à leur complet développement et peuvent poursuivre leur évolution, les chenilles issues d'oeufs pondus avant le 15—20 juin. Elles se réfugient sous les écorces des abricotiers et, dans les cultures des coteaux valaisans, bon nombre d'entre elles trouvent un abri sur les souches de vigne, sous les écorces ou dans la moelle des plaies de taille.

Une faible proportion de ces chenilles évolue la même année en papillons qui apparaissent après la cueillette des abricots, mais nous ignorons comment, en l'absence de fruits, ils se comportent dans les cultures pures.

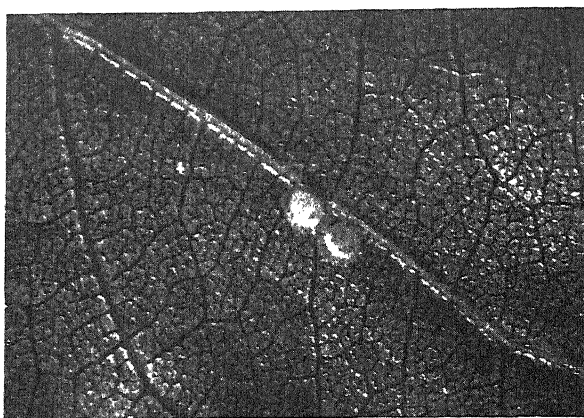


Fig. 3. Deux oeufs à la face inférieure d'une feuille d'abricotier. — (Gr. 6 fois.)

Tout comme dans les deux cas précédemment cités, nous avons affaire en Valais à une adaptation secondaire relativement tardive puisqu'il s'est écoulé au moins 30—40 ans avant que *E. pomonella*, connu depuis fort longtemps dans le pays comme ennemi des poires et des pommes, devienne un ravageur permanent et important des abricots. L'analogie est non moins frappante avec le cas du Carpocapse des noix en Californie, bien étudié par Quayle (1926) et il est curieux de noter que le temps qui s'est écoulé entre l'apparition du Carpocapse (1873 selon Essig), qui, lui, est le premier venu, et l'observation des premières noix véreuses (1909) est du même ordre de grandeur qu'en Valais.

Quels sont les facteurs qui vers 1930 ont favorisé le passage du Carpocapse sur l'abricotier et son installation dans les cultures des coteaux valaisans?

Si les observations et les expériences que nous avons faites jusqu'à maintenant ne nous permettent pas de répondre à cette question, il nous paraît cependant intéressant de relever ici quelques particularités frappantes.

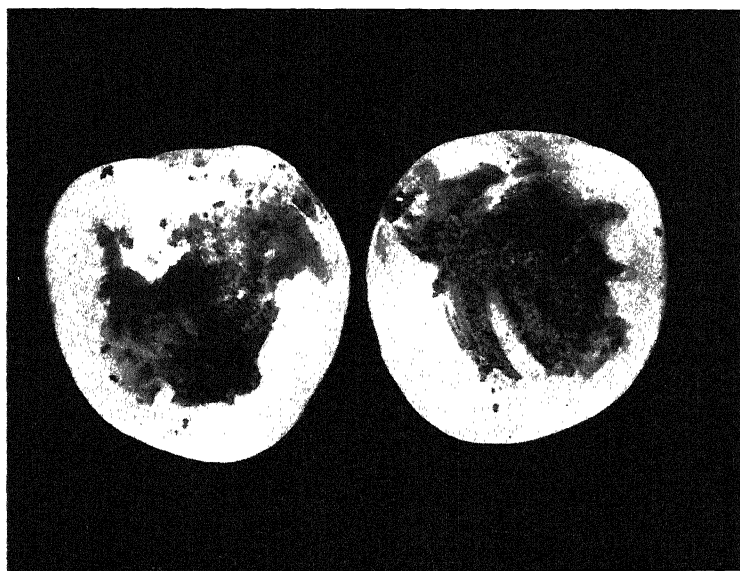
Le contrôle du vol des papillons qui est effectué régulièrement chaque année depuis 1943, d'une part dans les cultures pures d'abricotiers du coteau à Charrat (poste No 1) et, d'autre part dans des cultures mixtes avec prédominance du pommier, au pied même de ce coteau, à Charrat (poste II) et à Saxon (poste III), les postes I et II étant à peine distants de 500 m., a mis en évidence, de 1943 à 1948, des populations de Carpocapse plus abondantes dans les coteaux (abricots) que dans la plaine. Et le fait qu'en 1947 en particulier, on ait enregistré un vol massif dans le coteau, avec 1630 papillons capturés dans 10 pièges jusqu'au 20 juillet et un vol relativement faible dans les cultures mixtes voisines (163 et 321 papillons) montre que les deux populations jouissent d'une certaine autonomie et que, s'il y a passages de l'une à l'autre, ils sont de faible importance.

Si les papillons apparaissent presque simultanément dans les deux zones, nous avons régulièrement constaté que le vol augmente beaucoup plus rapidement dans les coteaux et y présente son maximum plus tôt que dans les vergers mixtes immédiatement voisins de la plaine. En 1945 et 1946, nous avons noté un décalage de 15—20 jours entre les maximums (fig. 6), en 1947, de 5—6 jours.





*Fig. 4. Pénétration de la chenille au point de contact de deux fruits.  
(Gr. nat.)*



*Fig. 5. Abricot véreux, avec chenille à son complet développement.  
(Gr. nat.)*

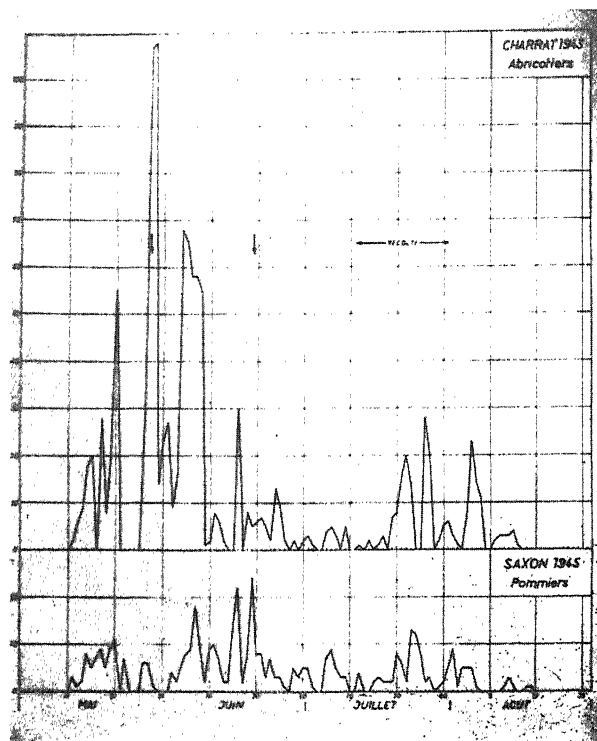


Fig. 6. Courbes de vol du *Carpocapse* dans les cultures d'abricotiers du coteau de Charrat (fig. 1) et dans une culture de pommiers au pied du coteau à Saxon en 1945.

Ces faits peuvent trouver une explication partielle dans les conditions d'hivernation des chenilles, mais il est possible qu'un autre facteur ait joué un rôle et que l'adaptation à l'abricotier ait favorisé dans la population du coteau, la sélection de lignées à apparition précoce.

Autre différence frappante : la proportion des chenilles de première génération qui entrent en diapause est plus forte dans les cultures d'abricotiers du coteau que dans les cultures de pommiers immédiatement voisines. En 1945 et en 1947, elle fut de 74—76 % pour les chenilles du pommier, de 92 à 96 % pour les chenilles des abricotiers, prélevées sous bandes-pièges posées à la même date et récoltées à la fin de la cueillette des abricots.

Ces chiffres, basés sur l'examen de plusieurs centaines de chenilles provenant de divers vergers tous très voisins, confirment un fait déjà mis en évidence par Pettey et semblent indiquer que l'adaptation à l'abricotier favorise la sélection de lignées univoltines.

Les expériences entreprises en vue de déceler des différences dans le comportement des papillons en présence de la plante hôte nous ont donné des résultats comparables

à ceux obtenus par Qu a y l e (1926). Dans des cages d'élevage d'une certaine dimension où des papillons issus de " vers " de l'abricot avaient à disposition pour y déposer leurs oeufs un rameau fructifère de pommier et un rameau fructifère d'abricotier, nous n'avons pas remarqué que ces papillons aient été impérieusement attirés par l'abricotier. Dans certains cas, la majorité des oeufs a été déposée sur le pommier, dans d'autres sur l'abricotier et sur onze expériences renouvelées dans des conditions diverses, nous avons compté :

491 oeufs sur pommier

446 oeufs sur l'abricotier.

D'autre part, le transfert de chenilles de l'abricot sur des pommes et vice versa n'affecte en rien leur évolution; les unes et les autres se développent normalement quelles que soient leur origine et la nature du fruit.

Rien ne nous autorise donc jusqu'à maintenant à considérer le *Carpocapse* nuisible à l'abricot comme une race biologique mieux adaptée à cet hôte; mais il apparaît possible que la population qui se maintient dans les cultures des coteaux soit différente dans sa composition génétique de celle qui infeste les vergers de la plaine. C'est ce que des recherches ultérieures permettront de vérifier.

Mais le fait que les dégâts de l'insecte sur abricotier ne sont vraiment graves que dans les cultures des coteaux semble montrer que les modifications dans la répartition des hôtes dans le biotope, en relation avec l'extension des cultures, ont dû jouer dans ce phénomène un rôle déterminant.

#### *Essais de lutte.*

En raison des interdictions légales et des dangers qu'ils présenteraient pour la santé publique, les composés arsenicaux ne peuvent être envisagés pour la lutte contre le *Carpocapse* sur abricot. Avant 1942, on ne disposait que de produits ovicides (nicotine, huiles nicotinées) qui, en raison de l'échelonnement des pontes et du développement rapide des oeufs sous le climat assez chaud du Valais, nécessitaient des applications trop fréquentes pour qu'elles soient recommandables et rentables.

*L'apparition, dès 1942, des produits DDT a permis de résoudre rapidement ce problème.*

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Nous avons entrepris nos premiers essais en 1943 avec des suspensions de DDT du type Gésarol, à 5 % de M.A., employées à la dose de 1 %. Elles nous ont donné de bons résultats, mais n'ont pu être recommandées parce que laissant trop de dépôt sur les fruits, qui apparaissaient souillés à la vente. Nous avons alors poursuivi l'expérimentation avec des émulsions de DDT à 20 % de M.A. qui, appliquées à la dose de 0,5 % se sont révélées remarquablement efficaces. Du fait que le produit adhère très bien sur le fruit duveteux, que la pluviosité est très faible dans la région, une seule application faite dès 6—8 jours après le vol maximum suffit généralement et assure une efficacité supérieure à 85 %.

Les résultats détaillés de nos essais paraîtront dans une prochaine publication; à titre de renseignement, nous communiquons ci-après ceux obtenus en 1946 avec la meilleure des émulsions expérimentées, qui est actuellement utilisée dans la pratique.

Produits	Date du traitement	Nombre d'arbres traités	Total des fruits	% fruits véreux	Efficacité
<i>Verger A</i>					
Emulsion DDT 0,5 %	5 juin	2	2611	3,7	86 %
Témoin	—	4	3433	25,8	—
<i>Verger B</i>					
Emulsion DDT 0,5 %	5 juin	3	2947	1,8	89 %
Témoin	—	4	2066	16,4	—
<i>Verger C</i>					
Emulsion DDT 0,5 %	5 juin	4	1838	1,6	96 %
Témoin	—	5	4210	37,3	—

L'abricotier n'hébergeant ni araignée rouge, ni puceron lanigère, l'emploi de produits DDT ne présente aucun des inconvénients que l'on observe sur les pommiers. Dès 1947, cette méthode de lutte est généralement appliquée en Valais, dans toutes les cultures menacées par le Carpocapse, et cela à l'entière satisfaction des praticiens.

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## INSECT CONTROL ACTIVITIES OF THE COMMUNICABLE DISEASE CENTER<sup>1</sup>

By *G. H. Bradley*

The Communicable Disease Center of the U.S. Public Health Service developed as an outgrowth of what was known during the recent war as the Office of Malaria Control in War Areas. That office originally was charged with the prevention of malaria transmission to military and industrial populations at the numerous camps, posts, and industrial areas which were located in regions of the country where malaria was endemic in civilian populations. To prevent duplication of effort, close working relationships with military and established civilian health organizations were maintained at all times. This malaria control work was almost entirely entomological in nature since the operations were directed toward control of the mosquito vectors of malaria. As has been reported by several authors, the hazard of transmission was so reduced that malaria did not become a problem among the protected groups in the United States. For this, the program was given major credit. (1, 2, 3, 4, 12). This success was largely responsible for the establishment of the Communicable Disease Center at the end of the war for the purpose of continuing certain training, investigational, and operational functions of the war-time Office of Malaria Control and in addition, to provide assistance to the several states on special phases of communicable disease prevention not previously available as federal government services. At the present time these services are concerned principally with those infections of man, which occur either exclusively or more intensively in the warmer climates and are transmitted by insects. However the feature truly common to this group of diseases in which the Center is concerned is that their vector and reservoir of infection and in some cases their etiologic agent also is of known or suspected animal nature. Included are all diseases of protozoan or helminthic origin, the most prominent of which are malaria, amebiasis, the schistosomiasis, hookworm disease, filariasis and similar diseases, and certain disorders caused by neurotropic viruses, the various forms of typhus and plague, sandfly fever, diverse diarrheas and dysenteries and possibly others. This grouping is essentially sound from the standpoint of the general type of services required for laboratory diagnosis, epidemiologic investigation, and control operations. In prosecuting these activities the basic operational organization established for the war-time work of combining the talents of physicians, engineers, and biologists, skilled and experienced in the control of insect and rodentborne diseases is being continued in the Center. A majority of the biologist group, as might be expected, is composed of professional entomologists or those having considerable entomological training.

Of the operational programs of the Center directed against insects, malaria control continues to be the largest. It has various phases, chief of which is the DDT residual house spraying program which is conducted in cooperation with the health departments of the thirteen states in which malaria is endemic. The program was undertaken in 1945 and has as its aim the eventual eradication of the disease as a public health problem in the United States. The essential operational features of the program call for: (1) the application of DDT residual coatings to the interiors of buildings

<sup>1</sup> Federal Security Agency, Public Health Service, U.S.A.

in rural and suburban areas for the killing of those anopheline mosquitoes which have close contact with man and thus are most likely to become infected with malaria; (2) the carrying on of anopheline larvicidal measures for the protection of communities having 2,500 population or more in counties where such work is indicated. The extent of residual spraying work performed through 1947 is shown in Table I.

TABLE I  
*Extended Malaria Control Program 1945-1947*  
*Summary of Residual House Spraying Operations<sup>1</sup>*

Year	No. Counties <sup>2</sup>	No. House Spray Applications	No. Houses Treated	Lb. DDT per Application	Man Hr. per Application
1945	121	678,000	400,000	0.45	1.75
1946	267	1,166,600	750,000	0.79	1.35
1947	326	1,317,000	900,000	0.80	1.20
		<i>For Summer Use</i>		<i>For Winter Use</i>	
		DDT	3 lb.	1 lb.	
		Xylene	3 qt.	2 qt.	
		Emulsifier			
		Triton X-100	6 fl. oz.	3.2 fl. oz.	
		or			
		Triton X-155	3 fl. oz.	1.6 fl. oz.	

For use, the summer formula is diluted with 6 parts water and the winter formula with 3 parts water, thus making 5% DDT spray in either case. The desired deposit of DDT per unit of area is obtained by regulating the delivery rate of the spray apparatus, the spray pattern, and the speed at which the sprayer works.

It is difficult to state the exact contribution this work has made in preventing malaria because of the continuing decline in incidence of the disease which the country as a whole has been experiencing since the middle of the past decade. Suffice it to say that the work undoubtedly has decreased the hazard of malaria transmission since inspections have shown that only 1 percent of treated houses harbor *Anopheles* mosquitoes compared to a normal house infestation of nearly 30 percent. Also, precipitin tests of the anophelines which persist about sprayed premises show that only one-fifth as many have had human blood meals as have those on unsprayed premises. (5, 6, 7). The trends of malaria mortality and morbidity in the United States are shown in Figure 1. (8).

Other phases of our mosquito control work include the surveying of hundreds of sites proposed for reservoir construction in connection with power development, conservation, etc. The status of disease-carrying mosquitoes in these areas and the probable conditions which will obtain after impoundment both in the reservoirs themselves and as a result of the use to which the water is put are given careful consideration. In the South and Southeast the control of the malaria mosquitoes is of

<sup>1</sup> In 1945 DDT was applied at the rate of 100 mg. per sq. ft. and in 1946 and 1947 at the rate of 200 mg. per sq. ft. Formula for DDT concentrates used are as follows:

<sup>2</sup> Thirty-one of the counties engaged in larvicidal activities during 1947. This work included the use of 105,000 man hours of labor to apply 184,000 gallons of larvicide (56,000 gallons fortified with DDT) to 25,000 miles of ditches and 15,000 acres of pounds and marshes; 43 hours of flying time to apply 1,400 gallons of DDT-oil solution by airplane to some 6,000 acres; and 47,000 man hours for cleaning 360 miles of ditches, clearing 31 acres of l.c. and constructing 13,000 cubic yards of earth fill.

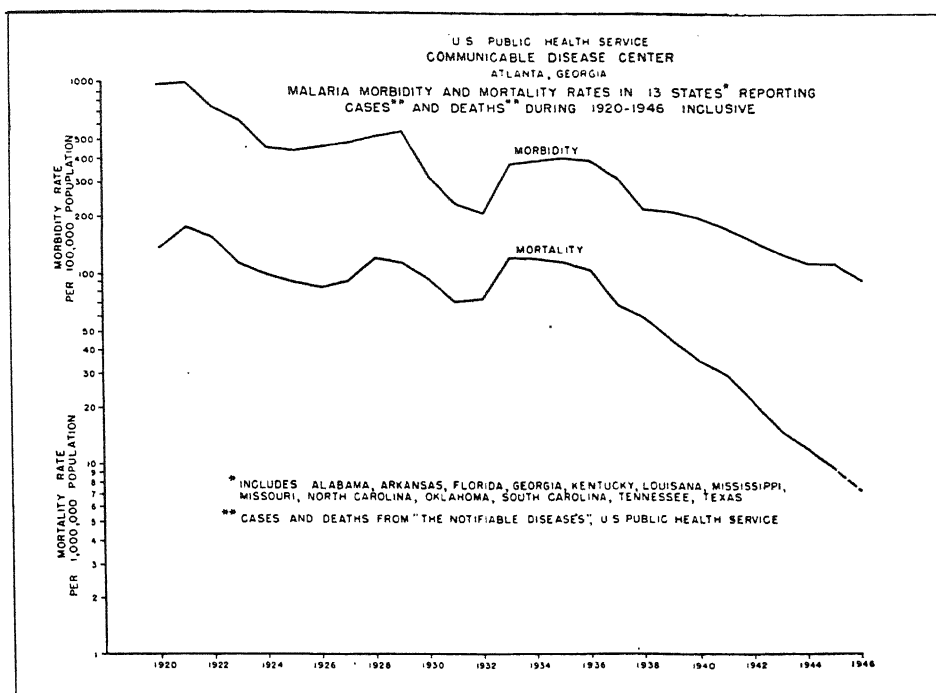


Fig. 1.

primary importance, while in the middle and far western parts of the country emphasis is placed on preventing practices which may increase the mosquito vectors of the arthropod-borne virus encephalitides. Based on the entomological data collected in these surveys, plans are worked out by engineers of the Center in cooperation with those of state health departments and of the construction and operating agencies for the incorporation of provisions for mosquito control in the design, construction, and operation of the reservoirs.

Studies are under way to accumulate data on the biologies of the specific mosquitoes responsible for carrying malaria and virus encephalitis particularly their flight ranges and breeding potentials in different latitudes and under different environmental conditions. The species of our anophelines concerned with malaria transmission are very well established. This is not, however, the case with mosquitoes concerned with the spread of the arthropod-borne virus encephalitides. Efforts are being made, therefore, to determine the mosquito species concerned in spreading these diseases in various sections of the country. Particular attention is being given to the avian reservoirs of these viruses, their habits, and the manner in which the virus is maintained in them. These investigations are concerned at present chiefly with bird ectoparasites, particularly mites, since these have been shown capable of passing the infection transovarially and are believed responsible for maintaining the infection in the avian reservoir.

Another important insect control program of the Center is directed against rat

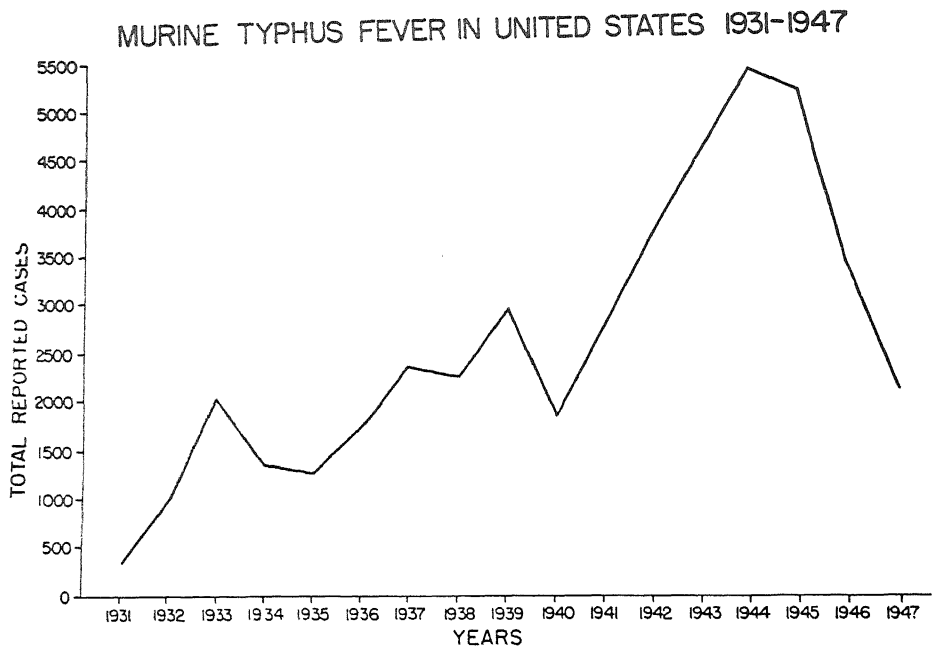


Fig. 2.

ectoparasites, principally *Xenopsylla cheopis*, for the control of murine typhus fever in the Southeastern States.

As is shown in Figure 2, this disease increased gradually in importance in the United States during the period, 1931 to 1945. During 1945, the year DDT dusting for rat ectoparasite control was begun on a comprehensive basis, a slight recession in human cases occurred, and the decline has been precipitous since. Dusting of rat harborage and runs with 10 percent DDT in pyrophyllite is the principal method used on the typhus control program, although rat-proofing, rat eradication, and general premises sanitation have been carried on concurrently in many counties. These supplementary activities may have been responsible for some of the decreased typhus incidence. It is felt, however, that the principal cause has been the effectiveness of rat ectoparasite control resulting from DDT dusting operations. These have been prosecuted in 123 counties of the country in which most of the typhus cases have occurred. A summary of the dusting operations is shown in Table II.

**TABLE II**  
*Murine Typhus Control*  
*Summary of Dusting Operations 7/1/45—12/31/47*

Period	No. Premises Dusted	Pounds 10% DDT Dust per Premises	Man Hours per Premises	No. Areas in Operation
7/1/45—6/30/46	331,912	2.5	.7	84
7/1/46—6/30/47	564,067	2.5	.5	123
7/1/47—12/31/47	189,575	3.5	.6	99



The results of the dusting work in decreasing both the percent of rats infested with *cheopis* and the average number of *cheopis* per rat or the "*cheopis* index" are shown in Figure 3. These data are based on the examination of some 32,000 live rats. The actual decrease in the *cheopis* index in dusted as compared to undusted premises approximates 85 percent.

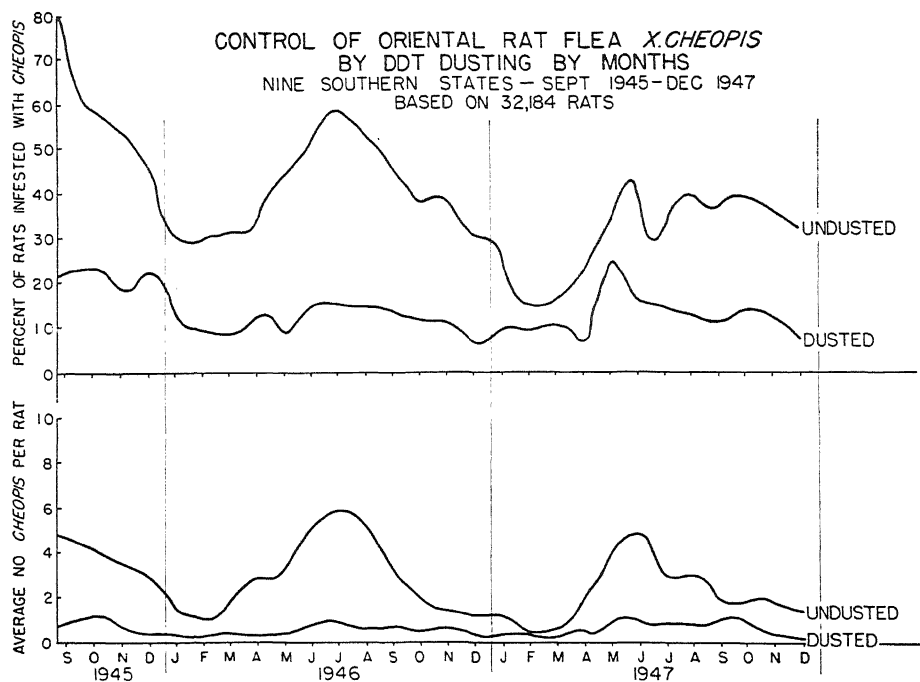


Fig. 3.

The effect of DDT dusting on typhus incidence among rats also is being determined. Some 24,000 complement fixation tests of rat bloods have been made, 13,000 of which were from dusted and 11,000 from undusted premises. The over-all results of these tests through 1947 show in general that only about 10 percent (27 percent vs. 37 percent) fewer rats from dusted premises are typhus positive. This narrow differential probably means that although the flea population is so reduced as to make typhus transmission to humans a rarity, it is not low enough to prevent active transmission from rat to rat. Of course, other ectoparasites not effectively controlled by DDT may be responsible for maintaining rat to rat transmission.

Although the incidence of murine typhus fever in the United States is declining precipitously in both dusted and undusted areas, the effect of dusting work in hastening this decline in treated areas is clearly evident. In 1944, the year preceeding the initiation of DDT dusting, there were 3,767 human cases of typhus reported from the 122 counties having highest typhus rates in nine Southeastern states. These counties subsequently were dusted. Cases reported in 1944 from the remaining 460 counties of these states in which no dusting was done totalled 1,446. In 1946, the first complete

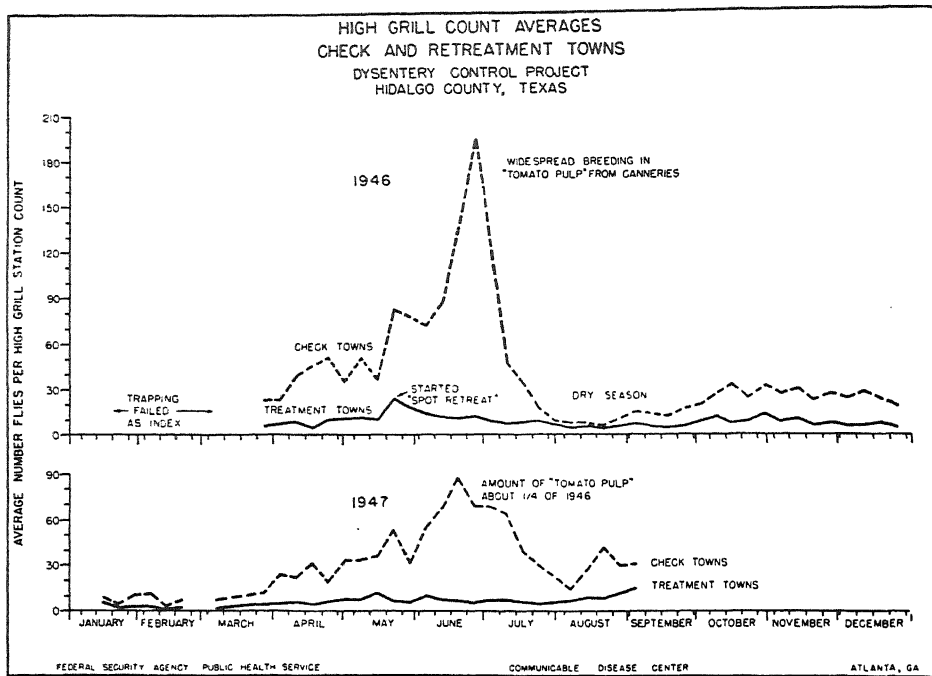


Fig. 4.

year of dusting operations, reported cases decreased 51 percent and 7 percent in dusted and undusted counties, respectively, thus giving a differential reduction in favor of the dusted counties of 44 percent (9). Preliminary analyses of data for the year 1947 indicate a continued decrease in reported cases in both dusted and undusted areas, but with a lessening differential in favor of those in which dusting operations have been carried on.

Investigational work to develop practical control methods and operational procedures for other insect carriers of disease are receiving a considerable amount of attention by the Center. In the field of fly control, intensive studies are being carried on in the lower Rio Grande Valley in Texas to determine the extent to which flies spread dysentery, whether they can be controlled effectively by the new insecticides, particularly DDT, and whether economically feasible municipal fly control programs can be developed to give the necessary degree of protection. The nine towns selected for these studies have a combined population of approximately 80,000, 56,000 of which are of Latin-American and 24,000 of Anglo-American origin. Dysentery rates in these towns were among the highest in the United States. The mortality rate from these diseases was extremely high during the period, 1942 to 1945, being frequently as high as 400 per 100,000 per annum in the Latin-Americans. Beginning early in 1946, five of the towns, having about half of the Latin-American population of the experimental area, were regularly treated as necessary for fly control using 5 percent DDT suspensions, emulsions, and solutions applied to exterior fly resting surfaces and as space sprays. In addition, fly larvicides, principally ortho-dichlorobenzene emulsion, were

applied to fly breeding places such as privy pits and refuse heaps as indicated, particularly during the early months of the program. No fly control work was done in the other four towns which were used as controls and which had population groups comparable to those of the treated towns. Careful entomological surveillance was maintained in both the treated and untreated towns, and indexes to fly populations were established based on grill counts following the method devised by Scudder, Figures 6, and 7. (10).

The results of the work have been quite phenomenal. The graphs in Figure 4 show the extent of over-all fly reduction obtained, and those in Figure 5 show the reduction in diarrhea rates in treated as compared to untreated towns. These figures are from a paper by Watt and Lindsay (11). These authors conclude from their studies that fly control in urban areas by insecticidal means alone is possible. However, because of the expense involved, they do not recommend this procedure in the absence of sanitary measures to eliminate principal fly breeding places. A definite reduction in diarrheal disease was obtained in the treated towns. Shigallae infections were markedly reduced, and salmonellae infections also were reduced but to a much smaller degree. Reported diarrheal diseases in sample population groups likewise decreased, and mortality from these diseases showed a similar trend.

After the first eighteen months of this study, the treated and untreated areas were reversed; that is, fly control operations were discontinued in the towns which had been under treatment, and control was begun in those towns which previously had been left untreated. As a result, fly control quickly was established in the newly

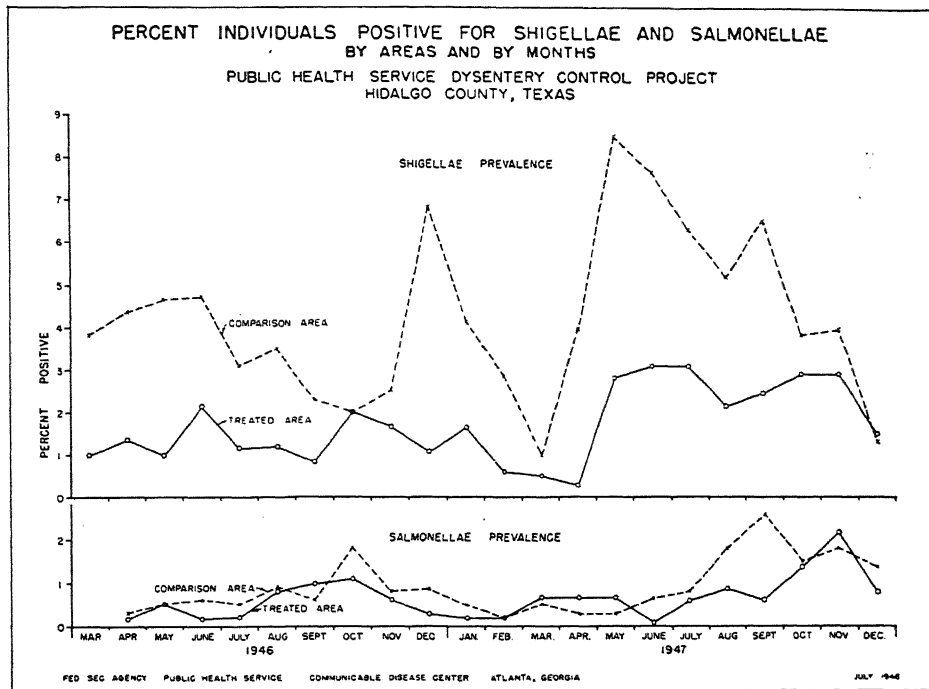


Fig. 5.

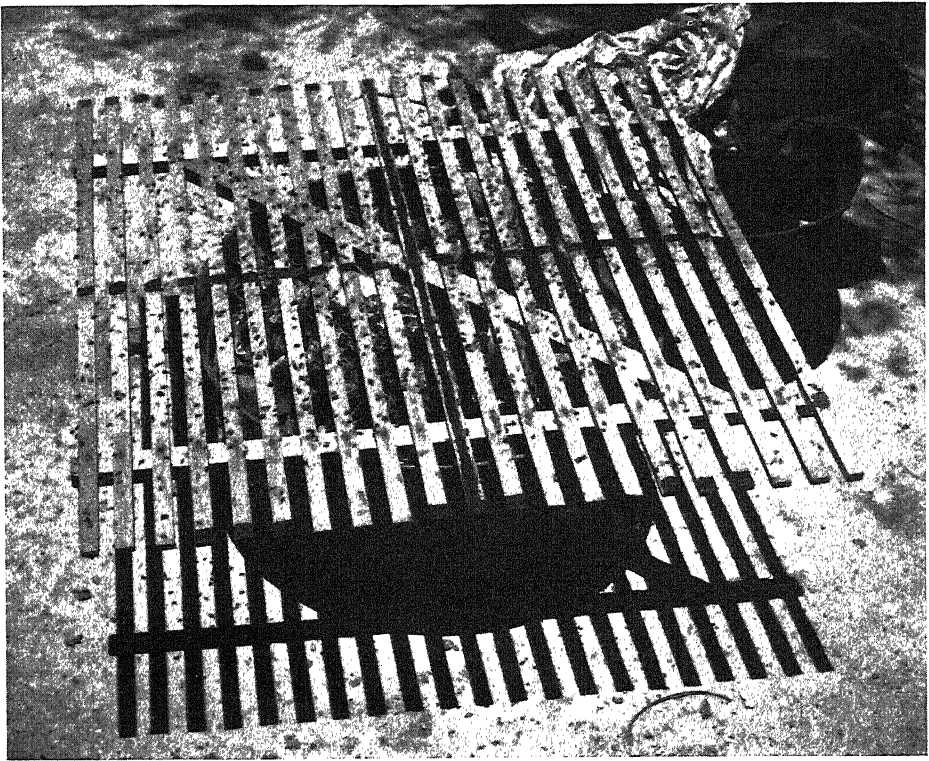


*Figure 6. Showing use of the "Fly Grill" to obtain an index to the fly population.*

treated towns, and within three months time morbidity, mortality, and diarrhea prevalence rates in the two groups of towns had been reversed. These rates became lower in the newly treated towns and higher in the previously treated towns where fly densities increased markedly as soon as control work was discontinued.

In addition to the data on the over-all fly populations shown in Figure 4, records have been kept of the percentage of the various species making up the fly populations in both groups of towns. However, the studies on the correlation of disease control with specific flies or groups of flies is not yet completed. Efforts also are being directed towards developing fly control procedures by which the necessary degree of fly reduction to effect disease control can be obtained most economically and how such procedures can best be integrated into city sanitary programs. Arrangements are now being made to conduct demonstration fly control projects in cooperation with municipalities in several parts of the country. The plans call for the intensification of sanitary clean-up measures in the selected cities and the integration of chemical fly control in their sanitary programs when necessary. The results of this work are to be measured by entomological criteria, and epidemiological studies are to be made to determine results in disease prevention.

In conclusion, I might say that my discussion necessarily has included only some of the highlights of the insect control activities for disease prevention carried on by



*Figure 7. Showing flies on "grill" in area of excessive fly density.*

the Communicable Disease Center. Details of the several control programs and results of investigational activities which I have mentioned have been published or will appear from time to time, and we will be pleased to send copies of our releases to those of you who are interested in this phase of entomology.

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## FACTORS AFFECTING APHID FLIGHT

By *L. Broadbent*

Since the aphid *Myzus persicae* Sulz. was recognized as an important vector of virus diseases, its ecology and habits have been the subjects of many studies. While working on the problem of potato seed production in North Wales, Davies (1934) discovered that the spread of leaf roll and rugose mosaic viruses was correlated with the number of alate *M. persicae* which entered the crop in early summer. Laboratory experiments on the effect of wind upon aphid flight (Davies 1936) showed that this is one of the major factors affecting the distribution of aphids, for *M. persicae* would not voluntarily take to the wing when the wind speed was over about 1.5 m. per sec. There was also not much danger of the aphid being involuntarily blown from the crop as it could cling to a glass surface and withstand the force of a gale.

It is often difficult to apply the results of laboratory experiments directly to the field, but field observations have confirmed Davies' findings. However, though there will be less opportunity for flight the more windy the day, there will be lulls when an aphid can take to flight on the windiest of days. Recent work at Rothamsted has attempted to relate the microclimate of the potato crop to that normally recorded at meteorological stations and has shown the relation between wind speeds at a height of 10 metres and those just above or within the crop (Broadbent 1948).

During the early weeks of plant growth, when the potatoes are first visited by aphids, an average wind speed of 1.8 m. p.sec. at 25 cm. above the ground would require an average of about 5.6 m. p.sec. at 10 metres. Later in the season an average wind speed of 1.8 m. p.sec. just above the crop (at one metre above the soil) would necessitate an average of about 3.3 m. p.sec. at 10 metres, and an average of 1.8 m. p.sec. within the dense crop would require about 15 m. p.sec. at 10 metres. It is clear that voluntary aphid flight can take place among and just above the plants on many days which would be considered unsuitable for flight from a perusal of the meteorological station records.

Laboratory experiments on the effects of temperature and relative humidity upon the flight of *M. persicae* led Davies (1935) to the conclusion that over 12.8° C relative humidities of 70 percent and above would greatly reduce flight. More recent field observations have shown that aphids do fly at high humidities and so laboratory experiments were made at Rothamsted to see if the differences between field and laboratory observations could be reconciled. Details of methods and results are described elsewhere (Broadbent 1949). The experimental chamber consisted of an inverted glass crystallizing dish in which the aphids were confined by a floor of copper gauze. This chamber could be placed over one sulphuric acid solution after another and the same aphids be exposed to different humidities. There follows a summary of the results obtained.

*The effect of age and conditions previous to test*

Preliminary observations showed that there was great variability between the batches of aphids. Further tests showed that young aphids (1—4 days after the last ecdysis) flew more often and showed less individual variability than older ones. Less than half of the alatae lived for more than nine days, although a few lived for three

weeks, under the glasshouse conditions in which they were reared, and they gave birth to more nymphs during their first three days as alatae than during any succeeding period of similar length. To minimise this variability alate aphids (*M. persicae* and *Brevicoryne brassicae* [L.]), were used whose ages since their final ecdyses were approximately known.

Aphids which had been exercised in the chamber on previous days were often less active than others which had remained on the plant. Starving increased activity for the first 1—2 hours. With all ages activity increased for the first few hours under experimental conditions, whatever the previous conditions had been.

#### *Periodicity in flight activity*

Alate *B. brassicae* were more active than *M. persicae*, but both species showed alternating periods of activity and quiescence. Most of the flights were of one second or less, though on one occasion a young *M. persicae* flew continuously for 11 minutes 8 seconds.

#### *Light intensity*

At light intensities between 100 and 1,000 foot candles there was little difference in flight frequency, but below 100 foot candles activity declined rapidly and apparently ceased with darkness. At low light intensities flight depended upon the previous conditions: thus *B. brassicae* being observed at 10 ft. candles were much more active after they had been exposed to a bright light than after exposure to a light of 2 ft. candles.

#### *Pressure*

Activity under conditions of fluctuating pressure ( $\pm 1/4$  inch of mercury) was greater than under constant pressure. Activity was much less than it was previously when a return was made to constant pressure following fluctuation. Although there was no evidence that the aphids behaved differently at different pressures, a temporary increase in activity often resulted when the pressure was quickly reduced  $1/2$  inch of mercury.

#### *Temperature*

The lower threshold of flight activity of *M. persicae* was about  $13^{\circ}\text{C}$ , which agrees with Davies' results. The response by the aphids to a change of temperature was very rapid, activity being sometimes greatest while the temperature was changing. Activity increased rapidly with increasing temperature to  $27^{\circ}\text{C}$ , after which there was little increase at 50 per cent relative humidity and a decrease at 90 per cent. *B. brassicae* were much more active than *M. persicae* at lower temperatures. Exposure to a high temperature ( $29.5^{\circ}\text{C}$ ) for a short period made *M. persicae* more active at lower temperatures than it was before. *B. brassicae*, however, were less active after exposure to high temperatures.

#### *Relative humidity*

Experiments showed that whereas changes in relative humidity affected flight frequency, (a change to a higher humidity often retarding activity for a short time and a change to a lower often increasing activity), aphids accommodated themselves to the particular humidity and after such accommodation flew equally well at humidities



ranging from 50 to 100 per cent. There was less response to a change to a high humidity at 21° C than at 32° C.

At first sight these results appear to conflict with those of Davies (1935), but the differences can be accounted for by the differences in experimental method. Davies left the aphids at the temperature of the experimental room for half an hour before introducing them into the experimental chambers and then left them for seven minutes before recording flights over a period of twelve consecutive minutes. Thus all the readings were made within twenty minutes of the aphids being introduced into the chambers. Davies did not state the humidity at which the aphids had been kept prior to introduction into the chambers, but presuming that it was in the middle range, introduction into a low humidity chamber would result in much greater activity than introduction into a high humidity chamber and would account for the results obtained.

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## NOUVELLES ACQUISITIONS SUR LES PTERINES DES INSECTES

Par René-Guy Busnel

Depuis le dernier Congrès International d'Entomologie, les progrès dans l'étude des ptérines ont été considérables, et nos connaissances de ces pigments, décrits pour la première fois chez les Insectes se sont étendues à tout le règne animal, avec des applications importantes en thérapeutique.

*Historique*

Jusqu'en 1929, seules des ptérines d'insectes des familles des *Pieridae* et des *Vespidae* avaient été décrites au cours d'une série de remarquables travaux; Hopkins (1889) en fut l'initiateur, et Wieland et ses élèves (1925—1939) isolèrent et décriront les caractères physico-chimiques de toute une série de ptérines de base. En 1943, Koschara identifia l'uroptérine qu'il avait découverte en 1936 dans l'urine humaine, à la xanthoptérine des Insectes.

De 1940 à 1944, Wieland et Schopf, Koschara, Purrmann réalisèrent les synthèses des ptérines isolées des ailes des Piérides.

Depuis cette époque, la nomenclature des ptérines s'enrichit de nombreuses découvertes dans divers ordres du règne animal :

*Homeothermes* (Koschara — Jacobson) *Poecilothermes* (Hüttel & Sprengling — Polonovski & Busnel) *Arthropodes Crustacés* (Polonovski & Verne & Busnel) etc. . . .

Parallèlement à ces descriptions de nouveaux pigments ptéridiniques les travaux physiologiques faisaient ressortir des propriétés importantes de ces pigments (1943—1946) : action de vicariance vitaminique; action chronaxique, action antithyrotoxine action anti-anémie pernicieuse (Travaux de Busnel, Polonovski et Coll., Jacobson).

En 1945 apparut une nouvelle série de ptérines obtenues aux Etats-Unis par Stocstead, les acides foliques, isolés soit de l'urine, soit du foie, soit de feuilles d'épinard. Ces ptérines répondent à une molécule formée de l'union d'une ptéridine (xanthoptérine) d'acide para-aminobenzoïque et d'acide l-glutamique. Cette constitution nouvelle est liée à des propriétés importantes se manifestant par une nette action hématopoïétique dans les anémies de Biermer et la sprue. (Totter & all)

*Etat naturel des Ptérines chez les Insectes :*

Les premières études biochimiques avaient porté sur des ptérines libres, isolées d'organes d'élimination : écailles des ailes, poils, hypodermes de Piérides diverses et de Vespides. C'est ainsi que furent caractérisés la *xanthoptérine*, son isomère l'*isoxanthoptérine* et son dérivé d'oxydation la *leucoptérine*. Chez les Insectes, les ptérines n'existent pas à l'état pur mais le plus souvent en mélanges complexes de diverses ptérines, et à côté d'autres substances comme l'allantoïne de l'iso-guanine (1925—1942).

Ces ptérines libres pouvaient donc être considérées avec raison jusqu'à présent par leur localisation et leurs propriétés physico-chimiques, comme des produits terminaux du catabolisme, bloqués dans les ailes et les hypodermes comme substances de déchets, et physiologiquement inertes.

C'est à ce type de ptérines que nous pouvons rattacher la ptérine que nous avons décrite (Busnel et Drilhon) dans le tube de Malpighi de la chenille de *Bombyx neustria* pigment fluorescent en vert, associé à l'acide urique, qui n'apparaît qu'aux tous derniers stades précédant le nymphose; il est expulsé après le filage du cocon, au moment de la dernière excrétion prénymphale, en colorant celui-ci en jaune soufre; ce cas d'excrétion de ptérine est jusqu'à présent unique chez un insecte. (1942)

Cependant chez les Vertébrés Inférieurs et chez les Crustacés, nous avons décrit (Busnel et Polonovski (1942—1944) des ptérines liées "in vivo" à des molécules protidiques, sous forme de chromoprotéides dissociables par modification de l'équilibre protéique, et notamment par des variations de pH (addition d'acides ou de bases) caractères classiques de la plupart des vitamines du groupe B.

Nous avons retrouvé récemment chez *Lepisma saccharina*, de telles ptérines, associées à des molécules protidiques, dans les hypodermes, ainsi que dans les tubes de Malpighi du microlépidoptère *Tinoca bissebiella*.

Cependant ces ptérines n'ont pu être observées qu'histochimiquement sans qu'une étude physico-chimique approfondie ait pu être abordée.

Nous pensons pouvoir rapprocher de ce groupe de ptérines, celles qui ont été signalées récemment par Bodine & Fitzgerald (1947) dans les oeufs de *Melanoplus differentialis* et que nous avions également observé avec M. Polonovski dans les oeufs de *Schistocerca gregaria* ou elles se trouvent associées à la riboflavine, analogue en cela aux ptérines que nous avons décrite chez les Crustacés et les Vertébrés Inférieurs. Il est également possible qu'on puisse rattacher à ce groupe de ptérines les substances décrites par Metcalf (1947) dans les glandes lumineuses de Lampyridae américains.

A côté de ces deux types de ptérines, soit libres, soit associées à une protéine, les acides foliques constituaient un groupe spécial par l'engagement de la molécule ptéridinique au sein des pigments naturels.

En effet, l'acide folique proprement dit est lui-même souvent engagé dans une combinaison oligo ou polypeptidique, suivant le nombre des molécule d'acide glutamique ajoutées (3 ou 7) formant alors ce que l'on a nommé facteur folique de fermentation ou vitamine Bc conjuguée.

Dans une série de travaux récents (1948) avec M. Polonovski, nous avons rencontré dans les oeufs de *Bombyx mori*, une molécule de nature analogue, constituée par un groupement ptéridinique et un polypeptide dans lequel nous avons mis en évidence l'acide glutamique, la sérine, la valine, le glyco-colle et la leucine.

#### *Les ptérines dans le métabolisme des Insectes.*

Il ne semble pas possible de conserver, pour les deux derniers types de ptérines (associées aux protéines (ptérines-ferment) ou apparantées au groupe folique) le caractère physiologique d'inertie que l'on a conféré aux ptérines libres. Néanmoins leur rôle n'a pu encore être mis en évidence.

Cependant, pour la ptérine complexe des oeufs de *B. mori*, nous assistons, au cours de l'évolution de l'oeuf, "in vivo", à une modification progressive de la ptérine, initialement à fluorescence bleue, en un composé à fluorescence jaune verte, signe d'une transformation biochimique que nous avons d'ailleurs pu obtenir "in vitro" par hydrolyse ménagée, avec libération du complexe aminé.

Les examens histologiques des ovules de divers Bombyx (*Saturnia pyri*, *Saturnia pavonia*, *Attacus cynthia*, nous avaient déjà révélé, il y a plusieurs années (Busnel & Drilhon 1942) une telle modification au sein de l'ovule, dans sa partie proto-

plasmique. Cette modification est le signe d'une activité physiologique qu'il reste toutefois encore à expliquer; les propriétés physico-chimiques de ces ptérines, et surtout leur potentiel d'oxydo-réduction permettent de penser que dans les tissus, elles participent hautement au métabolisme, hypothèse pour de futures recherches.

*Actions vitaminiques des ptérines chez les Insectes :*

Chez les Homéothermes on a démontré l'action vitaminique des ptérines naturelles ou de synthèse (Polonovski, Busnel & all. 1943—1947), qui se révèle comparable à celles des vitamines B<sub>1</sub> et B<sub>2</sub>, phénomène que nous avons appelé "vicariance" et qui, nous l'avons démontré, est étroitement lié à l'intégrité des flores intestinales. Jusqu'à présent il n'y a eu que peu de travaux sur les Insectes; Goldberg, Meillon & Lavoipierre (1945) ont observé que des substances contenant de l'acide folique sont indispensables à la nymphose des larves de *Culex*: Fraenkel & Blewett (1946) ont noté le rôle favorable de divers acides foliques sur la croissance d'*Ephesia kuehniella* et *Tenebrio molitor* (Acide folique cristallisé de Lederle, et vitamine Bc conjuguée de Parke & Davis).

Avec A. Drilhon (1948 et recherches inédites), nous avons étudié l'action de la xanthoptérine et de l'acide isoxanthoptérinecarboxylique sur la croissance de la larve de *Tenebrio molitor*, élevée avec des régimes dépourvus de vitamine B<sub>2</sub>.

Ces ptérines ont une action favorable sur la croissance, mais cette action ne se manifeste plus si on détruit les flores symbiotiques par des antibiotiques naturels (Streptomycine) ou de synthèse (sulfaguanidine).

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## L'ACHAEA CATELLA GUEN. NELLA SOMALIA ITALIANA

Dal A. Chiaromonte

Ho avuto già l'occasione, trattando degli insetti dannosi al Ricino (*Ricinus communis* L.) nella Somalia Italiana, di richiamare l'attenzione su *Achaea catella* Guen. (Lep. Noctuidae) dannosissimo, con le larve, alle foglie di questa pianta oleaginosa che, in quella colonia, al tempo delle mie ricerche sugli insetti del Cotone (ricerche che estesi a quelli di tutte le piante d'importanza economica del comprensorio di bonifica della Società Agricola Italo-Somala, al Villaggio Duca degli Abruzzi), era coltivata in coltura specializzata e come frangivento. Ma, se la segnalazione voleva far conoscere la presenza, sia pure saltuaria, di un insetto tanto pericoloso, mai prima indicato nella fauna entomologica di quella regione, essa rimaneva sempre tale anche se era accompagnata da qualche cenno sulla repentinità della sua comparsa, sulla rapidità dell'attacco e sulla subitaneità della sua scomparsa. Desidero, ora, in questa comunicazione, riprendere l'argomento tenendo conto non più soltanto delle mie poche e frammentarie osservazioni, ma della letteratura, convinto come sono che esso merita, per la sua importanza, una più ampia trattazione.

Il 3 gennaio 1926, chiamato dal Capo della IV azienda della S. A. I. S., visitai, con lo stesso, un appezzamento di Ricino che trovai completamente distrutto; le piante erano ridotte ai soli fusti ed ai rami, senza una foglia, come se su di esse fosse passata un'orda di cavallette. Il danno, mi fu riferito, era stato prodotto in pochi giorni. Dopo un'attenta ispezione, riuscii a raccogliere alcune larve mature del lepidottero incriminato che non avevo mai, prima d'allora, trovato su quella pianta e la mia prima preoccupazione fu quella di conservare i pochi esemplari per la collezione in alcool, annotando il reperto inconsueto, nella speranza di ritrovare altre larve nella stessa e nelle altre aziende della zona di colonizzazione dove il Ricino si trovava in coltura, praticamente, tutto l'anno. Pur troppo, nonostante le mie accurate ricerche durate fino a novembre del 1926, non rinvenni mai più una sola larva del Nottuide (nè, nel resto di quel mese ed in dicembre, ne vidi mai nella Colonia Eritrea, dove il Ricino era pure coltivato sebbene in misura più ridotta). Al tempo della mia osservazione, verosimilmente, le larve, abbandonando le piante, erano scese nel terreno o, sulla superficie, nascoste tra i resti della coltivazione, iniziavano il periodo di ninfosi. Non si potrebbe spiegare diversamente la loro estrema rarità sulle piante defogliate del tutto. Non mi capito, sulle piante, d'incontrare le crisalidi. Non conobbi la farfalla che, per le dimensioni delle larve mature (5 cm. ed oltre), si poteva giudicare dovesse essere piuttosto grande. Questa lacuna fu colmata solo in seguito, quando, nel 1931, nel materiale entomologico ricevuto dall'agronomo coloniale R. Tozzi, da Alessandra nell'Oltregiuba, per l'identificazione, io riconobbi le larve del Nottuide e gli adulti che la cortesia di Sir G. A. K. Marshall, direttore dell'Imperial Institute of Entomology di Londra, dai suoi specialisti fece determinare per *Achaea catella* Guen. Da quel tempo, comunque, nessun'altra segnalazione è stata fatta al laboratorio di Entomologia dell'Istituto almeno fino al 1940 quando, con la guerra e poi con l'occupazione, la Somalia Italiana è rimasta, si può dire, tagliata fuori dalle relazioni con il nostro Paese.

*L'Achaea catella* Guen. è indicata in Africa per l'Africa del Sud, per il Sudan e per la Somalia Italiana (compreso l'Oltregiuba), ma sembra anche per l'Africa equatoriale francese sebbene sia stata, qui, confusa con *Achaea janata* L. che è specie



*Achaea catella* Guen.: farfalla e larva vista di fianco e dal dorso. (Fot. orig., gr. nat.)

propria della regione indo-malese ed assolutamente non presente in Africa; nel Sud Africa e nella Rhodesia meridionale ad arrecar danno a frutta, nel Transvaal, nell'Africa equatoriale francese, nel Sudan e nella Somalia Italiana (con l'Oltregiuba) come peste occasionale del Ricino. Si conoscono le abitudini dei Nottuidi fruit-piercing moths che, oltre ad altri generi, comprendono specie diverse del gen. *Achaea* di cui *catella* Guen. non è, però, la più importante. Jack R. W., Gunn D. per il Sud Africa, Hargreaves E. per la Sierra Leone, Patterson W. H., Cottrell G. S. e Box H. E. per la Costa d'Oro, Golding F. D. per la Nigeria hanno lavorato sui lepidotteri, specialmente Nottuidi, che hanno farfalle perforatrici di frutta ed i loro studi anche su quelle del gen. *Achaea* (e altri) sono veramente interessanti e nei riguardi dell'indicazione delle frutta mature attaccate, tra cui primeggiano gli Agrumi con eccezione del limone, ed in quello del modo di attacco che non discrimina frutta a buccia integra da quella a buccia precedentemente per altra causa, anche entomatica, intaccata, della natura del danno (la perforazione e la suzione inducono un'ossidazione dei tessuti ed una fermentazione negli stessi che precedono la caduta delle frutta dalla pianta ed il marciume anche per il successivo attacco da parte di *Drosophila*, Dipt. Ephydridae, dell'entità del danno (che, in certe annate, è veramente grave ed in qualche caso ha costituito, per qualche frutto, come il mango, un fattore limite alla sua esportazione), della biologia, dei nemici naturali e finalmente, della lotta. Sebbene le specie del gen. *Achaea* abbiano costumi notturni, le farfalle sono state trovate a succhiare frutta nelle ore antimeridiane in giornate con cielo coperto e talvolta in numero di diverse per un solo frutto, io non ho mai avuto occasione di notare, non pure adulti di *A. catella* Guen., ma adulti di altri generi di Nottuidi a cibarsi su frutta come mango, *psidium*, annone, banane ed altre subtropicali e tropicali oltre ad arance, pompelmi ed altri Agrumi che ho studiato per gli insetti diversi che li attaccano. Nè ho avuto modo, pur essendo indicate alcune delle specie come fortemente richiamate dalla luce delle abitazioni, di catturare quella in oggetto mentre soltanto uno o due esemplari riferibili ad *A. algira* L. ed alla forma *albivitta* Moor sono nella collezione della Missione. Niente potrei dire delle piante spontanee su cui si svilupperebbero le larve i cui adulti, anche a distanza notevole, migrerebbero nei frutteti ad attaccare, nel modo ch'è riportato dagli AA., le diverse frutta mature;

le larve, evidentissime per la loro colorazione, distinguibili per le loro dimensioni e caratteristiche per aver meno sviluppate le pseudozampe del primo paio che fanno incurvare, nel cammino, più del normale, la parte anteriore del corpo e per avere sul dorso, in corrispondenza dell'ottavo segmento addominale, due non piccole prominenze a forma di cornetti rivolti all'indietro, io non ho trovato, ripeto, che una volta sul Ricino, mentre, per ragioni di studio, non ho trascurato di visitare la vegetazione spontanea nelle vicinanze immediate e mediate di questa e delle altre coltivazioni. E nemmeno ho mai assistito, nel periodo di tempo trascorso nell'Africa Orientale Italiana, a migrazioni di farfalle, a spostamenti, cioè, in massa, di adulti, da una località ad un'altra. Beninteso, queste mie precisazioni, per *A. catella* Guen. sui fruttiferi della Somalia Italiana, non vogliono, nella maniera più assoluta, infirmare i reperti sicuramente precisi degli AA. citati, ma, negativi come sono, per le mie osservazioni, vogliono dimostrare soltanto che, per quanto a me consta, non si possono estendere alla specie in discorso che, torno a dire, non è dannosa, nella Somalia Italiana (Oltregiuba compreso), che al Ricino.

Sul Ricino, le notizie che si hanno di *A. catella* Guen. come defogliatrice della pianta con le larve, sono meno esaurienti. Nê me per l'Africa equatoriale francese, Bedford H. W. per il Sudan, penso, si devono esser trovati di fronte al Nottuide, per quanto certamente meglio di me preparati, nella condizione in cui, press'a poco, mi sono menuto a trovare io per i pochi reperti che ho, dianzi, riferito per la Somalia Italiana. Se, però, le osservazioni di questi AA., quelle che io, più modestamente, ho fatto, si vogliono integrare con quelle che su una specie affine, *A. janata* L., per la regione indo-malese si posseggono in maniera molto più abbondante, io credo che si possa ricostruire, con molta verosimiglianza, la biologia incompleta che per la specie africana ha bisogno di essere ancora accertata se le informazioni che sono in mio possesso sono esatte. Subramanyam Iyer T. V., per l'India, già nel 1920, constatava che le ova del castor semi-looper erano deposte isolatamente, dalle femmine fecondate, la notte, alla pagina inferiore delle foglie, potendo, una femmina deporle intorno a 400; l'incubazione durava, nello Stato di Mysore, dopo le piogge di giugno-luglio, quando compare la peste, 2—4 giorni; la durata del periodo larvale era stabilita in 15—21 giorni, quando, raggiunta la maturità, le larve abbandonano la pianta su cui mangiano le foglie lasciando solo la nervatura in quelle vecchie ed il fusto principale nelle piante giovani (il getto terminale ed il fusto tenero di piante giovanissime sono ugualmente divorati), scendendo sul terreno per incrisalidare tra le erbe secche o le foglie sotto le piante stesse. La ninfosi può avvenire anche tra le pieghe delle foglie e tra le frutta dell'infruttescenza e lo sfarfallamento avviene dopo 10—14 giorni. Una generazione si completa in 27—39 giorni. Le generazioni annue sono due e la prima cagiona il danno più grave. Susainathan P., per l'India meridionale, si occupa della specie per riguardo all'attività degli adulti sugli Agrumi specialmente e per la Malesia, come peste, con le larve, del Ricino; Hutson J. C., per Ceylon, indica, fra le piante attaccate, oltre il Ricino, il Melograno e *Pericopsis mooniana* Thw. sempre per le foglie; Gosh C. C., per Burma, la cita sul Ricino; Van den Meer Mohr J. C. riporta la specie dannosa a semenzai di Tabacco a Sumatra; Garthwaite P. F. riferisce un'invasione di larve ad alberi di tung (*Aleurites fordii* Hemsl. ed *A. montana* Wilson oltre che a *Xylia dolabriformis* Benth. in Burma; Ramakrishna Ayyar T. V. per il Deccan l'indica sul Ricino ma aggiunge che l'importanza della farfalla come succhiatrice di frutta è sconosciuta, mentre, molto recentemente, Raksnpal R. riferisce che danno notevole ad Agrumi, esclusi limoni, è stato



cagionato dalla specie nello Stato di Gwalior dove anche le frutta acerbe, in mancanza di quelle mature, furono attaccate e l'attacco ebbe luogo sempre dopo la mezzanotte indipendentemente dalla presenza o dalla mancanza di luce lunare. Il succo gocciola dalla perforazione ed attira insetti secondari, le frutta marciscono per un'area circolare attorno al punto di suzione, tendono a maturare prima ed invariabilmente, entro una settimana, cadono dall'albero. La specie è infrenata nel suo sviluppo da animali predatori ed è attaccata da insetti parassiti, ma è considerata una peste da combattere con i mezzi che gli AA. suddetti indicano e nelle coltivazioni di Ricino e nei frutteti insieme ad altri Nottuidi con farfalle perforatrici di frutta. Anche per *A. janata* L. si ammette la migrazione a distanza delle farfalle che spiegherebbe l'improvvisa infestazione di larve, a Pusa, secondo Fletcher T. B. Per l'Assam, McSwiney J. riporta la specie sul Ricino e per le Indie orientali olandesi, van Hall C. J. J. accenna a defogliazione prodotta dalle larve a piante di Gutta-perca (*Palaquium*).

Trascuro, per *A. janata* L., le segnalazioni di Tryon H. per il Queensland relative al danno che la specie arreca al Ricino e quelle di Jarvis E., per la stessa regione, anche per la Canna da zucchero; alle Hawaii la specie è ricordata da van Zwaluwenburg R. H. con le larve su *Cordia subcordata* Lam. mentre è considerata l'importanza potenziale della farfalla come perforatrice di frutta ed infine, alle Figi, è citata da Lever R. J. A. W. con le larve a danneggiare piante di Rosa; esse servono ad indicare che l'area di distribuzione geografica della specie esorbita già da quella della regione indo-malese vera e propria.

Dopo quanto è stato riferito, io credo che si possa, prudentemente, arrivare alle seguenti conclusioni, almeno per la Somalia Italiana (e per l'Oltregiuba): 1) *L'Achaea catella* Guen. è specie veramente molto dannosa al Ricino; 2) il suo attacco, per l'estrema voracità delle larve, può distruggere completamente le piante giovani col fusto ancora erbaceo e defogliare del tutto quelle vecchie di cui si salvano le parti lignificate, con conseguenze molto gravi per la produzione; 3) la sua comparsa, a periodi più o meno lunghi di tempo, non trova, allo stato attuale imperfetto delle conoscenze sulla specie, spiegazione plausibile, a meno che non si voglia ammettere che la stessa, vivendo su piante ospiti spontanee, ancora non note, non si mantenga in limiti regolari di sviluppo normalmente e che, in condizioni estremamente favorevoli, si riproduca in modo eccezionale, dando luogo a sfarfallamenti massivi con conseguente migrazione degli adulti; 4) la rapidità dell'attacco può spiegarsi con la notevole prolificità delle femmine e con la brevità della durata del periodo d'incubazione delle ova; detto attacco, all'inizio, può sfuggire all'osservazione superficiale essendo diversi gl'insetti che vivono diversamente a spese delle foglie (*Cyrtacanthacris tatarica* L., Orth. Locustidae; *Thalassodes digressa* Walk., Lep. Geometridae; *Prodenia litura* F., Lep. Noctuidae; *Spilosoma investigatorum* Karsch., Lep. Arctiidae; *Argyroplote wahlbergiana* Zell., Lep. Tortricidae; *Acrocercops conflua* Meyr., Lep. Gracilariidae; *Euproctis convergens* P. Bak., Lep. Lymantriidae ed *Ozarba brummea*, Lep. Noctuidae; *Anaphothrips alternans* Bagn., Thys. Trypidae; *Empoasca facialis* Jac., Hem. Cica-dellidae, ecc.) ed infestano in maniera più o meno grave la pianta; 5) la sua scomparsa improvvisa, probabilmente, potrebbe esser messa in relazione con la migrazione osservata in altri paesi per altre specie di *Achaea*, più che con l'azione esplicata dai nemici naturali che insidiano la vita del Nottuide.

Ma si è ancora nel campo delle induzioni e delle deduzioni e, meglio, delle ipotesi che, in Entomologia applicata, servono meno, indubbiamente, degli studi, studi che devono essere condotti seriamente sul Nottuide e sui suoi simbionti per conoscerne con

precisione la biologia allo scopo di poter indicare come ridurne materialmente il danno. Fino a che le conoscenze di *A. catella* Guen. sul Ricino restano quelle che sono, l'ispezione continuata delle coltivazioni di questa pianta dev'essere fatta regolarmente ed al primo accenno della presenza delle larve, l'intervento con trattamenti a base d'insetticidi per ingestione (arseniato di piombo o di calcio all'1 %) dev'essere fatto tempestivamente; la raccolta a mano delle larve, dove l'operazione risulti non eccessivamente onerosa, può costituire un mezzo sussidiario di quello principale indicato, mentre le lavorazioni al terreno potranno, eventualmente, interrare o portare alla superficie una parte delle crisalidi impedendone o, quanto meno, disturbandone lo sfarfallamento e comunque, esponendole all'azione degli agenti atmosferici ed a quella dei possibili nemici naturali.

L'*A. catella* Guen. rappresenta una vera calamità per il Ricino nella Somalia Italiana (e nell'Oltregiuba), anche se la sua azione dannosa si manifesta dopo periodi più o meno lunghi di tempo in cui la specie sembra essere in quiescenza; essa può essere, tuttavia, combattuta bene e se la lotta è condotta con energia e sopra tutto è fatta in tempo, è possibile mettere la pianta in condizione di produrre salvando il raccolto da sicura distruzione.

#### SUMMARY.

The A. reports on *Achaea catella* Guen. (Lep. Noctuidae) whose larvae are noxious to Castor plants in Italian Somaliland (and Jubaland), makes some considerations on the species of the genus with fruit-piercing moths, completes his observations with those of other Authors on a similar species: *A. janata* L., in view of establishing its presumable biology and while advising a complete study on the spot, suggests the means for saving the crop from sure destruction.

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## LA TEIGNE DE LA BETTERAVE EN FRANCE (*Phthorimea ocellatella* Boyd. Lépid Gelechiidae)

Par A. Couturier

Les 3 dernières années de 1945, 46 et 47, exceptionnellement chaudes et sèches en France, ont provoqué la pullulation anormale d'insectes habituellement peu commun. En particulier, la Teigne de la betterave (*Phthorimea ocellatella* Boyd.) a causé des dégâts dans presque toutes les cultures situées au sud de la région parisienne. Les plantations les plus touchées se rencontrent en Bourgogne, à proximité de Dijon, mais des attaques importantes ont été observées aussi dans l'Yonne aux environs de Sens, en Charente près des Forges d'Aunis, en Limagne non loin de Clermont-Ferrand et dans la vallée du Rhône. De tels ravages ont déjà été signalés en France par Marchal (10) dans des circonstances analogues (1874, 1906), mais ce sont surtout les pays à climat chaud et sec qui souffrent habituellement de l'Insecte (Espagne, Maroc, Italie, Turquie). (8)

### Biologie —

Les papillons entrent en activité à la tombée du jour, les accouplements peuvent s'observer dès que la température atteint 11 degrés C, ils ont lieu généralement de bon matin et peuvent se poursuivre pendant plusieurs heures. La ponte est soumise au même seuil thermique de 11 degrés. La femelle ne dépose pas ses oeufs sur une surface plane, elle les insère dans les fentes ou rugosités offertes par le pied de betterave. Au printemps elle recherchera les bords encore enroulés des toutes jeunes feuilles, plus tard elle pourra se porter au niveau du collet, contre les vieux restes des pétioles desséchés. La structure complexe des inflorescences offre aussi des lieux de ponte propices. Une femelle peut donner en quelques jours jusqu'à 50 oeufs répartis en petits groupes de 1 à 6, sa longévité peut cependant atteindre 25 à 30 jours.

L'oeuf ovale (0,5 X 0,3 mm) est blanc avec des reflets nacrés. Après un temps d'incubation variable selon la température, il en sort une larvule gris jaunâtre qui accomplit toujours une petite migration pour chercher un point de pénétration dans les tissus de la plante. Elle restera ensuite cachée durant toute son existence.

Le comportement de la chenille rappelle beaucoup celui de *Phthorimea operculella* Zell (13). Elle présente de même un *thigmotropisme* très prononcé selon lequel elle ne peut pas rester à découvert, mais éprouve le besoin de vivre à l'intérieur d'une toile très fine tissée par elle-même. Avant d'ouvrir une galerie, elle édifiera un abri léger à partir duquel elle entamera la plante. Elle tapissera encore d'une trame soyeuse les parois de toutes ses galeries : canaux translucides creusés dans l'épaisseur d'une feuille ou tunnels forés dans la racine. Cette habitude a pour effet d'empêcher le contact direct du corps avec les tissus végétaux aqueux. Les excréments et les exuvies des mues sont rejetés au dehors et s'accumulent à l'orifice d'entrée sous forme d'amas noirâtres caractéristiques. La couleur verte des excréments frais, provenant d'une mine foliaire, révèle la persistance de plastés chlorophylliens non digérés par la larve. Dans la nature celle-ci s'en prend rarement aux feuilles bien étalées, déjà négligées par les pondeuses, et dont la surface lisse ne présente pas assez de points d'appui pour construire une base de

départ. Elle se porte de préférence dans les pétioles ou dans les petites feuilles du coeur, encore enroulées sur les bords et serrées les unes contre les autres. Elle les attaque alors en les maintenant plus étroitement accolées à l'aide de fils de soie unissant leurs faces internes. Plus tard les feuilles déformées garderont un gaufrage particulier décelant la présence du Lépidoptère.

Les nervures sont entièrement dévorées, la chenille semble même les mordre de préférence au parenchyme, elles constituent fréquemment l'axe de galeries menant au pétiole.

Les larvules nées sur une racine se portent en premier lieu vers les petits bourgeons du collet. Si elles ne trouvent pas de tissus tendres à proximité, elles peuvent entrer directement dans la chair en prenant appui dans une fissure quelconque de l'écorce. Ces galeries ne descendent jamais profondément, elles se maintiennent toujours auprès des surfaces exposées à l'air libre. Il ne s'agit pas d'un tropisme lumineux mais plutôt de la recherche des régions les moins riches en eau. L'habitat, plus facilement aéré, sera moins chargé d'humidité. La chenille n'hésite pas, en effet, à s'enfoncer au milieu d'une racine déjà attaquée à la périphérie, mais en restant toujours au voisinage des autres galeries. Le développement peut s'accomplir entièrement aux dépens de la racine et les larves ont la possibilité de terminer leur évolution dans les silos de betteraves.

Arrivée à la fin du dernier stade, la chenille, devenue rouge carminé sur la face dorsale, se porte vers les lieux les plus secs pour effectuer sa métamorphose. Fuyant un sol mouillé, elle choisit des herbes ou des feuilles sèches, ou encore des cavités de pierre. En élevage le sable sec convient parfaitement à cet Insecte dont l'hôte primitif est *Beta maritima* L., plante du littoral nord-atlantique et méditerranéen.

Ainsi, tout le comportement de la chenille est régit par un *hydrotropisme négatif*.

Le cocon a l'aspect d'une petite dragée de 5 à 7 mm. de long sur 3 de large. Il est formé d'un tissu léger retenant agglomérés des éléments fins quelconques : débris végétaux, particules terreuses, sable. Très serré à l'extrémité postérieure, il est beaucoup plus lâche au pôle antérieur près duquel se trouve la tête de la chrysalide, ce qui facilite la sortie du papillon.

La chenille accepte toutes les variétés de betterave cultivée (sucrières, fourragères ou potagères), ainsi que la Bette ou Poirée, mais elle paraît s'attaquer seulement au genre *Beta*. Les Chénopodiacées et Polygonacées sauvages ne semblent pas lui convenir.

Au laboratoire nous avons réalisé aisément l'élevage de *Ph. ocellatella* sur des variétés potagères rouges, globuleuses et de petit format. Pour éviter l'encombrement, la partie effilée de la racine pivotante est coupée le plus haut possible, il en est de même des feuilles sectionnées au niveau du collet. Les femelles pondent sans difficultés dans les anfractuosités du collet et les chenilles pénètrent dans la racine peu après l'éclosion. Lorsque les larves sont parvenues au dernier âge, les betteraves nourricières sont portées sur un lit de sable sec dans lequel se font les cocons, ceux-ci sont recueillis par tamisage.

La durée du développement de la Teigne de la betterave varie beaucoup selon la température (cf. tableau).

Température		15°,1	16°,9	23°,6	25°,1	25°,6	26°,8	29°,2	32°	35°,6	35°,8	41°	to
Durée d'incu- bation	oeufs	16—17j		7—7,5j		5j		4—5j		3,5—4j			12—13°
	cocons	42—45j		14—15j		13—14j		8—9j		6—6,5j		7,5 lethal	11—12°

Le zéro (10) se situe autour de 11 à 13 degrés pour l'oeuf et la chrysalide. La durée d'incubation du cocon comprend aussi l'intervalle de temps qui s'écoule entre la formation du cocon et la chrysalidation de la chenille, il faut compter 6 à 7 jours à 15° et 3 jours seulement à 26°. A cette dernière température la chenille fraîche éclore met 15 à 20 jours pour effectuer son complet développement et le cycle évolutif se poursuit en 35 à 40 jours de la ponte à la sortie du papillon. Dans les mêmes conditions *Ph. operculella* Zell (4 et 10) et *Ph. lycopersicella* Busck (9) demandent seulement 25 jours. A 41° le papillon parvient à se former, mais il meurt sans pouvoir quitter la chrysalide.

L'activité des chenilles s'arrête aux environs de 10°, au-dessous elles sont encore capables de s'abriter sous une toile mais elles ne se nourrissent plus; au dernier stade elles ne parviennent pas à se chrysalider dans le cocon nouvellement formé. A l'approche de la mauvaise saison les différents âges poursuivront leur développement tant que la température restera supérieure à cette limite. Les betteraves encore en végétation seront toujours susceptibles d'héberger des larves. Celles-ci peuvent, en outre, achever leur cycle dans les silos où sont entreposées les racines, elles iront se mettre en cocon dans les points les plus secs au niveau des cheminées d'aération. Aidés par la chaleur du milieu des adultes peuvent apparaître au cours de l'hiver, ils attendront les premiers beaux jours pour sortir à l'air libre et contaminer les toutes jeunes plantations. Les papillons provenant des chrysalides formées avant les froids se joindront bientôt à eux, ainsi que ceux donnés par les chenilles d'automne. Le premier vol, échelonné sur les mois d'avril et de mai, pourra donc causer de très bonne heure de graves préjudices aux cultures. Une seconde sortie aura lieu, sous nos climats, en juillet et août, elle sera suivie parfois d'un troisième vol si les conditions de température le permettent comme cela s'observe dans le midi de la France.

Le climat tempéré à caractère océanique auquel sont soumises ordinairement les grandes régions betteravières de France suffit à réduire la pullulation de *Ph. ocellatella* qui se cantonne habituellement dans la région méditerranéenne. La longue période sèche et chaude de ces dernières années a facilité le développement de la souche indigène dont les ravages se sont étendus bien avant vers le nord. La pluviosité excessive du début de l'été 1948 va gêner considérablement l'Insecte et contribuera efficacement à faire regresser rapidement l'invasion observée en 1947.

#### Parasitisme —

Les chenilles de *Ph. ocellatella* récoltées à la fin de l'automne 1947 aux environs de Dijon ont donné 2 Hyménoptères *Braconidae* : *Chelonus* (*Chelonella*) *contractus* Nees et *Agathis propinqua* Kok <sup>(1)</sup>.

*Ch. contractus* a déjà été signalé en Italie sur la Teigne de la betterave par Menozzi (12) qui indique en outre *Agathis tibialis* Nees et *Apanteles albipennis* Nees.

Nous n'avons pas obtenu de mâles de *Chelonus*. Les femelles vierges se sont reproduites au laboratoire en donnant uniquement des femelles (*parthénogénèse thélytoque*). L'oeuf parasité éclot normalement. La chenille se développe sans paraître indisposée, mais elle s'enferme prématurément dans un cocon beaucoup plus petit qu'à l'ordinaire. L'hôte est alors dévoré avant la formation de la chrysalide. Le parasite repu tisse à son tour un cocon parcheminé à l'intérieur de celui déjà édifié par le Lépidoptère. La sortie du *Chelonus* se produit quelques jours après l'apparition des papillons issus de cocons formés en même temps que celui de la chenille parasitée.

<sup>1</sup> Détermination faite obligeamment par M. Granger.

Les deux cycles se correspondent bien. Le *Braconidae* peut présenter autant de générations que le *Tineidae*, l'hibernation a lieu à différents stades selon l'état de développement de l'hôte.

En Italie du nord, d'après Vance (16), la reproduction de *Chelonus annulipes* Wesm., parasite de *Pyrausta nubilalis* Hübn., est normalement bisexuée et les individus des deux sexes s'y rencontrent en nombre égal. Les femelles vierges sont capables de pondre mais les oeufs non fécondés donnent toujours des mâles (parthénogenèse arrhénotoque). La thélytoque observée en France, près de Dijon, chez *Ch. contractus* peut-être sans doute considérée comme une parthénogenèse géographique; son aire de répartition s'étendrait plus au nord que celle de l'espèce bisexuée.

Le genre *Chelonus* a des représentants dans toutes les parties du monde. Il a déjà joué un rôle important dans la lutte biologique entreprise contre divers Lépidoptères. En 1929, l'espèce européenne *Ch. annulipes* Wesm. a été introduite aux Etats-Unis d'Amérique, puis au Canada. Il s'est parfaitement acclimaté (16). *Ch. Texanus* Cress. a été recherché en U.S.A. pour lutter contre des *Noctuidae* en Afrique du Nord et aux Iles Hawai (14). *Ch. pectinophorae* Cushm. originaire du Japon, a été introduit dans les plantations de coton du Texas pour combattre *Platyedra gossypiella* Saund. (1). Enfin *Ch. Phthorimaea* Gah. parasite de *Ph. operculella* Zell. a été envoyé successivement de Californie en Australie (18) et aux Iles Bermudes (19).

Etant donné la facilité avec laquelle certaines espèces de ce genre peuvent changer d'hôtes (5), *Ch. contractus*, dont la parthénogenèse thélytoque facilite l'élevage, pourra être appelé à rendre de grands services.

### Moyens de lutte

Pour atteindre *Ph. ocellatella*, dont l'évolution s'effectue presque entièrement à l'intérieur de la plante, il faut agir sur les états les plus accessibles c'est à dire de très bonne heure sur les oeufs ou sur les toutes jeunes larves en cours de migration.

Nos études de laboratoire ont permis de préciser le mode d'action des principaux insecticides de contact. Une émulsion diluée de *Deris* et d'alcool terpénique sulfoné (7,5 gr. de Roténone par hectolitre de bouillie) présente une action franchement ovicide en arrêtant complètement le développement des oeufs. Les composés organiques de synthèse en émulsion (D.D.T. : 50 gr., H.C.H. : 100 gr., S.P.C. : 36 gr. par hectolitre) (2) provoquent la mort de la chenille au moment de l'éclosion; celle-ci, incapable de se libérer, reste dans l'oeuf. Chaboussou a déjà obtenu des résultats analogues sur des oeufs de *Hoplocampa flava* L. (6) et *H. brevis* Klug. (7). Le S.N.P. (2) employé sous forme d'émulsion (10 gr. par hectolitre) ou de poudrage (1 %) se montre, aussi, larvicide à l'éclosion.

Les suspensions contenant 100 gr. de H.C.H. ou 140 gr. de S.P.C. par hectol. exercent une action moins complète sur l'oeuf, beaucoup de chenilles peuvent éclore mais elles meurent généralement au cours de la première migration. Quant aux poudrages (D.D.T. : 4 %, H.C.H. : 8 %, S.P.C. : 10 %, Phénothiazine, Rotenone : 0,75 %), ils ne semblent pas influencer la vitalité des oeufs mais ils agissent efficacement sur les jeunes chenilles.

<sup>2</sup> D.D.T.: Dichlorodiphényltrichloréthane; H.C.H.: Hexachlorocyclohexane; S.P.C.: Sulfure de Polychlorocyclane; S.N.P.: ester phosphorique ou ester diéthylique de l'acide paranitrophénoxythiophosphorique; Phénothiazine = Thiodiphénylalanine.

Des essais de lutte en plein champ sont en cours en Bourgogne (3). Les premiers traitements, effectués fin avril au moment du maximum du premier vol des papillons, ont donné des résultats satisfaisants, en particulier le poudrage au H.C.H. à 8 % (15).

Il est possible actuellement de combattre directement *Ph. ocellatella*, mais la mise au point et la diffusion d'appareils à grand travail retardent encore l'application aux cultures de betterave des résultats obtenus au laboratoire.

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<sup>3</sup> Les essais de lutte en plein champ sont entrepris en collaboration avec M. Soulie, Inspecteur du Service de la Protection des Végétaux, circonscription de Beaune.



OBSERVATIONS PRELIMINAIRES SUR LA BIOLOGIE D'UN NEMATODE  
(*Mermithidae*) PARASITE DE LA LARVE DU HANNETON COMMUN  
(*Melolontha melolontha* L.)

Par A. Couturier

Les pâturages de la haute vallée de la Saône ont été en grande partie détruits par des "Vers blancs" au cours de l'été 1947 (larves de *Melolontha melolontha* L., régime 2 ou uranien). La sécheresse a accentué les dégâts et les herbages des cantons de Monthureux et de Lamarche (Vosges) montraient au printemps 1948 de grandes taches dénudées où toute végétation avait disparue. En ces points la densité des larves dépassait souvent 70 au m<sup>2</sup>. A St-Julien, certains prés citués en bordure de la Sale et de la Saône renfermaient en automne 1947 des Vers blancs dont les trois quarts étaient parasités par un Nématode filiforme de la famille des *Mermithidae*<sup>1</sup>.

Les larves attaquées se reconnaissent aisément à leur teinte jaune orangé et à leur aspect légèrement vitreux. Les *Mermis* sont généralement bien visibles à l'intérieur de leur corps, en particulier dans le dernier segment abdominal. Un même Ver blanc peut contenir jusqu'à 17 larves de Nématode des 2 sexes, de taille très variable et dont l'extrémité postérieure, obtuse, ne présente ni appendice, ni trace de cicatrice. La plupart des parasites quittent l'hôte au cours du mois d'octobre; celui-ci meurt peu après pendant que les *Mermis* vivent à l'état libre dans le sol où ils se rassemblent en peloton pouvant comprendre une dizaine d'individus.

Au laboratoire ils ont été placés dans des récipients (tubes, boîtes de Pétri, etc.) contenant du sable humide, lavé, stérilisé et calibré de manière à éliminer les fines particules, passant au tamis No 20 à mailles de 1,03 mm., et les gros éléments retenus par le tamis No 15 à mailles de 1,63 mm.

Le Ver parvient seulement à l'état adulte après une mue qui se produit 30 à 40 jours après la libération. Les mâles, plus petits, sont facilement reconnaissables à leurs spicules assez courts placés non loin de l'extrémité postérieure, leur longueur dépasse rarement 100 mm. Les femelles, au contraire, peuvent atteindre plus de 300 mm., leur vagin est en forme de S étiré, elles portent sur la face ventrale un très petit mamelon situé à l'emplacement correspondant, chez les mâles, à la sortie des spicules (Fig. 1). Ils vivent tous dans le sol aux dépens de leurs propres réserves et ne prennent aucune nourriture au milieu extérieur.

Une femelle non fécondée, et maintenue isolée, ne paraît pas capable de se reproduire; mise en présence d'un mâle, elle peut se mettre en ponte peu après la fécondation. Les premières pontes ont été observées au laboratoire en février, 3 mois après la dernière mue (température de 15 à 16° C). Les oeufs, très petits, sont presque sphériques avec 40 à 50 microns de diamètre sur les axes.

Toutes les minutes environ, un paquet d'une quarantaine d'oeufs se détache de utérus et chemine en bloc dans le vagin. Les oeufs sont expulsés très rapidement un par un et apparaissent à l'extérieur légèrement aplatis, mais ils prennent vite leur

<sup>1</sup> Müller a décrit de Breslau en 1931 *Megalomermis melolonthae* espèce très différente et mal définie (femelle 280 mm., mâle 70 mm., oeuf avec deux enveloppes de 120 à 180 microns).

forme sphérique (Fig. 2). L'évacuation du groupe demande une dizaine de secondes suivie d'un intervalle de 35 à 45 secondes pendant lequel 40 à 50 unités se présenteront à nouveau pour être pondues (température de 15—16° C)<sup>2</sup>. Les oeufs sont légèrement retenus les uns aux autres par un mucus qui durcit au contact de l'argile du sol. Il se forme ainsi de minces plaquettes maintenant agglomérés un grand nombre d'éléments disposés côte à côte sur une, deux ou trois couches d'épaisseur.

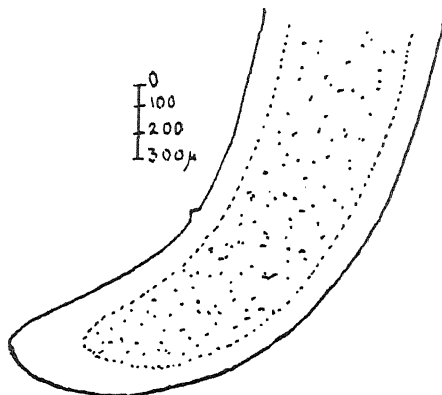


Fig. 1. Extrémité postérieure de la femelle.

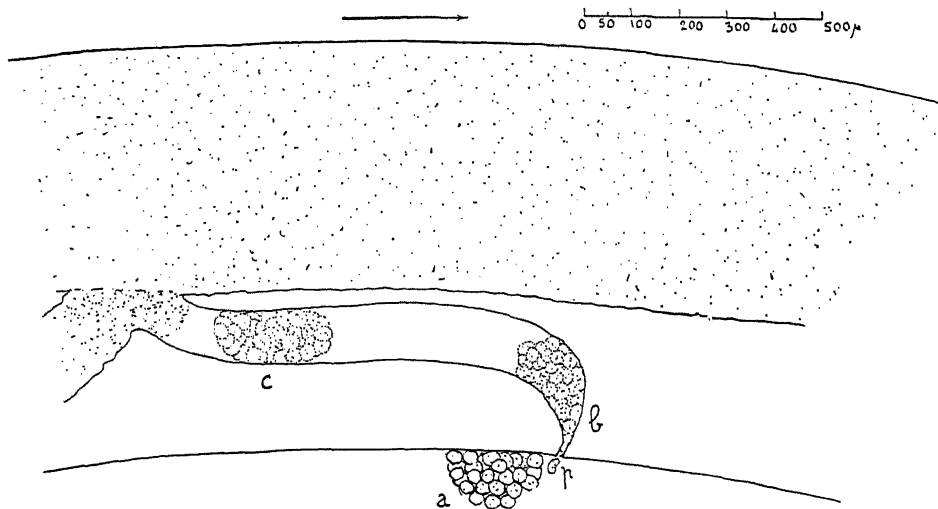


Fig. 2. Ponte. a : oeufs fraîchement pondus encore appliqués contre le corps de la femelle — b : groupe d'oeufs en cours d'évacuation — (p : oeuf déformé venant d'être expulsé) — c : groupe se déplaçant dans le vagin — la flèche indique la direction de la tête.

<sup>2</sup> "Une femelle a présenté deux vagins de même orientation aboutissant chacun à un orifice de ponte particulier. Ces derniers, distants l'un de l'autre de 690 microns, fonctionnaient presque en même temps."

La ponte dure 15 à 20 jours durant lesquels la femelle est toujours en mouvement par glissement et torsion. Cependant elle ne parcourt par une longue distance car elle est fréquemment enroulée sur elle-même et reste plusieurs jours au même emplacement. La pondreuse dont la couleur est à l'origine d'un blanc ivoire légèrement jaunâtre, prend vite une teinte laiteuse; les millers d'oeufs déposés autour d'elle forment une tache blanchâtre ayant l'aspect d'une moisissure. Le Nématode se vide peu à peu de sa substance au cours des trois semaines de ponte, il meurt quelques jours après. Le total des oeufs rejetés, considérable, peut-être évalué approximativement de 500.000 à 800.000 au moins pour un individu mesurant 250 à 300 mm. de longueur.

L'incubation dure plus de deux mois (température de 17 à 20° C). La masse de cellules résultant de la segmentation s'allonge et s'étire peu à peu en un boudin devenant de plus en plus fin. Celui-ci s'enroule en spire dans l'oeuf qui, vu par transparence, présente alors l'aspect d'une couronne. La larvule mesure à l'éclosion 300 à 350 microns de longueur pour un diamètre de 10 microns.

Les premières pontes ont commencé au milieu du mois de mars dans les prairies de la Saône, presque un mois avant la remontée des Vers blancs. Les éclosions peuvent se produire dès la fin de mai. Les larvules contaminent probablement les larves du Han-ton dans le sol, au moment d'une mue larvaire.

Les *Mermis* ont été rencontrés en abondance en certains endroits seulement des prés les plus humides. Cette localisation en quelques points refuges tient peut-être à l'excessive sécheresse des années précédentes qui a entraîné la disparition du parasite des lieux les moins arrosés, favorisant d'autant le développement des Vers blancs.

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## LE CRIQUET MIGRATEUR (*Locusta migratoria* L.) DANS LE SUD-OUEST DE LA FRANCE

Par J. Feytaud

L'invasion du Criquet migrateur dans les landes de Gascogne est, à mon avis, le fait entomologique le plus marquant qui ait été constaté en France au cours des dernières années. Elle a débuté apparemment en 1945, au mois de juin, sur deux aires distinctes de la région de Bordeaux : à l'Ouest de la ville entre Saint Jean d'Illac et le Temple, au Sud entre Croix d'Hins et le Puch, aux confins des communes de Cestas, le Barp et Mios.

C'est le 21 juin qu'un entrefilet de journal signala les premières constatations; je me rendis aussitôt à Saint Jean l'Illac pour contrôler la présence des bandes de criquets; je fis aviser tout de suite les services officiels et je prévins M. Vayssière, professeur au Muséum, qui envoya sur les lieux un de ses collaborateurs, M. Carayon.

Aux premiers jours de juillet, alors que les insectes commençaient à subir la mue imaginale, leur densité était si grande par places qu'on les écrasait par centaines sur la route d'Arès et sur la voie ferrée Bordeaux—Bayonne.

La plupart avaient déjà leurs grandes ailes vers le 10 juillet; le 13, on notait des vols, qui prirent plus d'importance de jour en jour; le 18, M. Carayon et moi assistions avec curiosité à la formation progressive et au départ des colonnes ailées. Le soir du 20 juillet, une forte nuée passait d'Ouest en Est au-dessus de l'agglomération bordelaise, et les habitants purent voir, à 40 ou 50 mètres de hauteur, des hirondelles et des moineaux s'y mêler pour faire une chasse très active aux sauterelles; le 21, une autre nuée survolait longuement l'aérodrome de Mérignac. Le 24, une troisième s'abattait comme grêle entre Lacanau et Carcans, faisant apparaître par places un tapis mouvant de 10 ou 15 centimètres d'épaisseur.

Il en arrivait aussi bientôt des quantités sur les communes de Lanton, Lège, Saumos, Martignas, Salaunes, Sainte Hélène et Castelnau; et, pendant des semaines, il y eut des allées et venues et des tourbillonnements de légions ailées dans le ciel entre le Bassin d'Arcachon et le Lac de Lacanau d'une part, la Garonne et l'estuaire de l'autre. Le soir venu, les insectes descendaient au sol, pour y passer la nuit; avant de repartir, ils dévoraient à qui mieux mieux les Graminées de toutes sortes, en particulier les maïs dont ils ne laissaient pas grand chose. A la même époque on en vit aussi s'envoler par essaims devant les grands incendies de forêt du Nord des Landes.

A la fin d'août et au milieu de septembre, la situation se révéla plus inquiétante aux yeux de ceux qui connaissaient le risque ou qui l'avaient subi, l'abondance des couples faisant prévoir celle des pontes.

En 1946, après une apparition prématurée sans lendemain signalée en février—mars près de Carcans, les éclosions se font partout sans entrave en mai—juin dans tous les secteurs précités; les criquets sont alors incomparablement plus nombreux qu'en 1945. Ils passent le 30 juillet en vaste nuée, dense comme un nuage, au-dessus de Bordeaux et vont s'abattre au Nord dans le canton de Blanquefort, où ils font des dégâts considérables sur les maïs et souillent de leurs excréments les prairies, rendant l'herbe restante impropre à l'alimentation du bétail. Une nuée plus dense et plus populeuse passe sur nous du Sud au Nord le 3 août.

L'amplitude des vols s'accroît au milieu de ce mois d'août; survolant le Blayais, les migrateurs arrivent en Charente les 17 et 18 dans les cantons d'Angoulême et de Villebois-Lavalette, où deux communes sont fort éprouvées par leurs ravages; une partie d'entre eux est allée tomber dans le Poitou et même au-delà, puisque des isolés ont été recueillis en Bretagne, en Ile-de-France ou en Angleterre.

En 1947, année encore sèche, alors qu'une défense énergique était organisée pour parer à une menace croissante, Bordeaux n'eut pas de nouvelles visites des gros criquets; mais de fortes nuées formées dans le Sud de la Gironde et le Nord des Landes ont été suivies au mois d'août, allant achever leur voyage les unes sur les contreforts des Pyrénées, les autres dans le Bas-Languedoc.

La multiplication considérable et l'évolution grégaire de *L. migratoria* L., qui n'était précédemment connue dans cette région que sous la forme solitaire (*L. danica* L.), est une des conséquences de la sécheresse qui a sévi sans discontinuer depuis six ans, de 1942 à 1947.

Avant que se révélât cette inquiétante pullulation, nous avons eu à déplorer la baisse du niveau des sources, l'anémie des pins altérés, la multiplication des incendies forestiers, ainsi que les ravages alarmants des Scolytides sur lesquels notre attention fut appelée un an plus tôt (1944).

Je ne veux pas discuter ici le problème posé par cette manifestation de grégarisme : il a été bien examiné par M. Zolotarewsky. Je dirai toutefois que, ni de mémoire d'homme, ni dans les archives de nos sociétés scientifiques, on n'a relevé aucun précédent pour le Sud-Ouest de la France. De vieux paysans de la région ont bien pu dire qu'ils avaient été témoins de vols analogues, mais je crains fort qu'il ne s'agisse de paroles sans fondement ou d'impressions de déjà vu si fréquentes en pareille matière.

Les conditions atmosphériques de 1948, très différentes de celles des années précédentes, vont sans doute déterminer un retour en arrière et tendre au rétablissement naturel du sédentarisme exclusif.

Je signale les observations qu'il m'a été donné de faire sur l'homochromie présentée par les criquets migrateurs, et par ceux des autres espèces, en rapport avec le milieu environnant. Au cours d'une prospection faite en août 1945 entre Belin et Lugos en compagnie de M. Hubault, j'ai constaté la teinte sombre de tous les sujets recueillis sur le sol noirci d'un quartier ravagé par le feu le 21 juillet, et j'ai retrouvé le même fait en d'autres lieux, au Las près de Saint Jean d'Illac et à Testaroman près de Pissos. J'ai eu sur ce dernier point la curiosité de comparer deux lots recueillis de part et d'autre et à quelque distance d'une route qui avait servi de limite à un grave incendie, et j'ai noté là encore une différence bien nette.

Il y a lieu de remarquer que les aîlés mélaniques de Belin, qui étaient du type *transiens congregans*, avaient dû subir la dernière transformation avant le 21 juillet, date de l'incendie, ce qui permet de soulever la question d'une adaption chromatique postérieure à la mue imaginale.

J'ai voulu contribuer à la mise au point des moyens de lutte en essayant comparativement, en poudrage, des insecticides de synthèse et des insecticides roténonés, aux premières semaines de la découverte. Pour en mieux noter les effets, je parquai les insectes en champ clos entre des panneaux grillagés. Les résultats les plus rapides ne furent donnés par du talc additionné soit de derris, soit de sulfure de polychlorocyclane

(S P C), dérivé sulfuré de l'hexachlorocyclohexane (H C H). Ces poudrages ont mis tous les Criquets en transes dans les deux heures et les ont tués dans les deux jours.

J'ai retenu particulièrement le S P C pour faire ensuite une analyse des symptômes d'intoxication; je mettais à profit les bonnes dimensions des *migratoria* pour déposer la poudre en certains endroits de la surface du corps à l'exclusion des autres. J'ai communiqué les résultats à l'Académie d'Agriculture de France le 10 avril 1946. Des essais ultérieurs avec l'H C H m'ont fourni des conclusions analogues.

La crise débute assez vite, au bout de 2 à 6 heures, quelquefois même plus tôt; après une courte période d'énervement que traduit une agitation désordonnée, il se produit un commencement de paralysie avec déséquilibre, puis un tremblement des pattes et des ailes, des convulsions, des crampes tétaniformes raidissant en extension les pattes postérieures, ces trémulations et ces crampes alternant pendant des heures sinon des jours (2 ou 3) avant d'aboutir à la mort, qui est fatale.

J'ai noté que tous les points du corps sont vulnérables, mais qu'en général la crise est plus brutale et la mort plus prompte quand le produit a été mis sur les pièces buccales, sur les stigmates ou sur la dépression tympanique, ce qui ne l'empêche pas d'être efficace lorsqu'il est déposé sur d'autres points du tégument.

En raison de sa forme et de sa taille, *Locusta migratoria* me paraît être un test de choix pour l'étude du mode d'action des insecticides.

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## LE DORYPHORE A LA CONQUÊTE DE L'EUROPE

Par J. Feytaud

Le Coléoptère *Leptinotarsa decemlineata* Say, couramment appelé Doryphore, Colorado Beetle, Kartoffelkäfer, est un des Insectes que le destin a le plus favorisés. La prospérité merveilleuse qui l'a mis en vedette ne remonte pas à plus d'un siècle. Vers 1850 il occupait une bien petite place dans le Monde; il était connu seulement des collectionneurs, qui le recherchaient comme un élégant et rare Chrysomélide faisant bonne figure dans un cadre vitré. Il appartient à un genre originaire de l'Amérique centrale et ne s'en est détaché en espèce particulière qu'à une époque récente, d'après les observations de Tower qui a écrit une remarquable étude sur la phylogénie des *Leptinotarsa*.

Sa nourriture essentielle était le feuillage d'un *Solanum* sauvage (*S. rostratum*); mais l'apport du *S. tuberosum* dans les Etats de l'Est et l'échelonnement progressif de sa culture entre la côte océanique et le versant des Montagnes Rocheuses allaient, au milieu du XIX<sup>ème</sup> siècle, modifier complètement son destin.

Le Doryphore a pris goût tout de suite à la Solanée tubéreuse, il s'est porté sur elle par prédilection; avide de son feuillage, il a profité de l'abondance offerte par les champs pour y donner libre cours à sa fécondité et pour s'y multiplier à l'aise; puis il a essaimé de proche en proche, de culture en culture, d'Ouest en Est, à une vitesse si grande que les Américains n'eurent pas le temps d'organiser la lutte et qu'en moins de vingt ans l'invasion s'étalait sur un très large front.

Témoin de l'avance foudroyante et massive, Charles Riley n'avait pas attendu cette échéance pour prévenir le Vieux Continent: "Il est fort possible, écrivait-il dès 1871, que l'Atlantique ne parvienne pas à l'arrêter; lorsqu'il fourmille dans les rues de New-York, une femelle pleine d'oeufs fécondés peut prendre asile à bord d'un navire en partance; que nos voisins d'Europe soient donc sur le qui-vive!"

Les "voisins" ont entendu le conseil, renouvelé de façon plus pressante en 1876. Ils ont été sur leurs gardes pendant des années, en raison d'apparitions locales vite reconnues; mais ils n'ont pu malheureusement éviter la surprise de l'implantation définitive du ravageur à l'issue de la première guerre mondiale. L'aire envahie était déjà trop grande au moment de la découverte (1922) pour que le mal fût extirpé; mais la mise au point immédiate d'une méthode de lutte efficace, qui n'a subi depuis que des retouches légères, a retardé la progression qui va gagner peu à peu l'Europe entière.

Le passage du Nouveau Continent à l'Ancien était le résultat d'un transport accidentel, transport d'une ou plusieurs femelles fécondées ou de quelques individus des deux sexes embarqués avec des marchandises quelconques (et pas forcément des pommes de terre), ou tombés en fin de vol sur un bateau. La longévité de l'Insecte qui, au stade adulte, peut demeurer vivant pendant des mois sans prendre de nourriture, rendait l'emprise facile en un temps où les gens d'Europe avaient de tout autres préoccupations. Mais une fois l'Insecte ancré sur notre territoire, son expansion s'explique fort bien par le simple jeu de ses moyens propres.

C'est un des phytophages les mieux doués pour la conquête; la diffusion considérable de sa plante de prédilection est un atout majeur qui lui fournit de quoi vivre partout,

sans compter qu'il dispose aussi à l'occasion d'autres espèces de Solanacées aptes à le nourrir et susceptibles d'assurer le déroulement de son cycle évolutif à défaut du *S. tuberosum*. L'aptitude au vol à longue distance, singulièrement amplifiée par l'action du vent, lui fait gagner vite des terres nouvelles qu'il annexe à son domaine, sans autres limites que celles de l'hôte favori auquel le sort l'a si étroitement lié.

L'envol, déterminé par l'état physique des insectes et par les conditions atmosphériques (les fortes températures surtout), plus que par la pénurie d'aliment, a lieu d'ordinaire pour beaucoup de sujets à la fois. Ce sont alors des départs massifs. J'ai cité en exemple l'activité fébrile dont je fus témoin le 17 juillet 1936 : en cette journée, exceptionnellement chaude dans presque toute la France, les insectes manifestèrent un impérieux besoin de prendre leur essor. On en vit se heurter aux murs des maisons, y grimper jusqu'au toit pour aller plus loin; pendant des jours on en écrasa des quantités sur les routes, dans les rues, dans les cours et les jardins; on eut nettement l'impression d'une pluie de doryphores.

On comprend que, ces départs massifs se répétant au cours des années chaudes, les gains territoriaux soient alors considérables. C'est ce qui eut lieu en France en 1933, 1934 et 1935, puis en 1937 et 1938. Cela se traduisit en 1934 par une diffusion brutale du ravageur sur le Berry et le Bourbonnais, en 1935 par une extension considérable dans tout le Nord-Est, en 1938 par l'arrivée d'insectes tombés du ciel en ordre épars sur l'Artois et les Flandres et par des chutes en ordre serré sur les côtes de l'Ouest.

La nappe envahissante, débordant nos frontières, gagna la Belgique en 1935, le Luxembourg et l'Allemagne en 1936, la Hollande et la Suisse en 1937, en même temps que la péninsule ibérique, et successivement, au cours de la guerre et depuis, le Portugal, l'Italie, l'Autriche, la Hongrie, la Pologne et la Tchécoslovaquie.

La séquelle des saisons chaudes et sèches de la période 1942—1947 a facilité cette ruée vers l'Est à travers l'Europe centrale où la défense avait été organisée cependant sans retard et appliquée sans faiblesse.

Il est évident que l'invasion va se poursuivre, gagner les Balkans, les pays Scandinaves, les pays Baltes et la Russie et qu'elle atteindra tôt ou tard l'Asie de la même façon. Le Doryphore est en train de conquérir tout notre continent en dépit des obstacles tels que l'eau et le relief, qui peuvent le retarder, mais qui ne l'arrêteront pas.

Seule l'immensité de l'Océan devait interdire le passage de l'Insecte livré à ses propres moyens. Aucun lac, aucun estuaire d'Amérique ou d'Europe n'est infranchissable pour lui. Les grands lacs de l'Amérique du Nord ont été vite dépassés avec l'appoint de la flottaison; les larges embouchures du Saint-Laurent, de la Delaware et de l'Hudson ont à peine freiné son avance; les lacs d'Europe ne comptent pas devant lui; les petits bras de mer qui séparent la France de ses îles de l'Ouest (Oléron, Ré, Noirmoutier, Yeux, Belle-Isle, Ouessant) ne les ont pas protégées bien longtemps; les îles anglo-normandes et le Sud-Est de l'Angleterre, quoique bien plus éloignés, ont reçu à plusieurs reprises des doryphores tombés du ciel en fin de course, assez épars heureusement pour qu'une intervention prompte et énergique ait permis à nos voisins insulaires de réagir avec succès. Il est vrai que les chances de salut et le nombre des survivants s'amenuisent d'autant plus que la distance est plus grande et que la majorité des insectes poussés vers la mer périssent sur les flots, ainsi qu'en témoignent les observations faites certains jours sur les plages de France, où le flux ramène des quantités de cadavres et de mourants.



Pour ce qui est du relief, il a été dit que les Rocheuses avaient fait longtemps obstacle à l'invasion des Etats de l'Ouest, où le Doryphore n'est apparu qu'en 1914 à la suite de transports accidentels, et l'on s'imaginait qu'en Europe les hautes chaînes feraient aussi l'office de barrages. Il n'en est rien. J'ai eu l'occasion de montrer que tout ce qui dépasse le niveau d'où les insectes prennent leur essor peut jouer le rôle d'écran (haie, mur, maison, rideau d'arbres, falaise, pente), rôle tout passager, simple retardement d'autant plus marqué que la saillie est plus relevée ou plus raide et qu'elle est située plus près du point de départ.

Par le jeu des courants ascensionnels, il doit arriver que les doryphores montent à plusieurs centaines de mètres au-dessus du niveau du sol; si l'on n'a pas, à ma connaissance, enregistré leur capture en altitude au cours de chasses en avion, on en a découvert à 2.000 mètres et plus sur des rochers ou des névés, au-dessus de pentes si raides qu'il ne pouvait être question d'une montée en rase-mottes. Il n'est pas douteux que le franchissement de collines ou de petits massifs montagneux puisse avoir lieu directement en plein vol; mais il se fait plutôt par infiltration dans les creux, ce qui est le mode constant pour les hautes chaînes.

Dès le début de l'invasion dans le Sud-Ouest de la France, j'ai fait remarquer la fréquence des alignements de foyers égrenés en chapelets le long des vallées. Cette disposition devint la règle lorsque l'Insecte réalisa la conquête du Massif central de la France, puis le passage des Vosges et du Jura et la traversée des Pyrénées et des Alpes.

L'entrée en Suisse en 1937 s'est produite à la fois au Nord et au Sud du Jura, par la trouée de Belfort-Bâle et la vallée du Rhône, et en plein milieu par le val de Joux et le val de Travers.

L'histoire de la transgression des Vosges est typique: arrivé devant elles en 1935, le Doryphore y marque le pas au cours des deux années suivantes, cependant qu'il déborde franchement par le Nord et le Sud pour atteindre les deux extrémités du pays de Bade; mais en 1938 il réussit à pénétrer au cœur même de la chaîne, forçant tous les cols pour envahir de front la plaine d'Alsace où il descend à la fois par les vallées de la Bruche, de la Liepvrette, de la Fecht et de la Doller.

Le forçement des Pyrénées est aussi remarquable; nous l'y avons vu à partir de 1934 monter à l'assaut des diverses vallées, à commencer par celles du Tech et de la Têt. Or, d'après l'ordre officiel des découvertes de foyers en Espagne, les premiers passages ont dû avoir lieu dans ce secteur, par les cols de Perthus et de Tosas (foyers de 1935 et 1936), avant l'entrée par la côte catalane (1937); puis on découvrit en 1938, dans le centre et l'ouest de la chaîne, beaucoup de foyers consécutifs à la pénétration par le val d'Aran, le Somport et Roncemaux, en même temps que par le Pays Basque.

L'histoire du passage de France en Italie à travers les Alpes est aussi curieuse, quoique plus localisée. L'insecte est arrivé dans le département de l'Isère en 1935, l'an d'après dans ceux de Savoie et de Haute-Savoie; en 1937, il y occupe de nombreux champs. Il s'avance en amont de Grenoble, égrenant des foyers tout au long du Grésivaudan, puis dans la haute vallée de l'Isère en direction du Petit Saint-Bernard et dans la vallée de l'Arc en direction du Mont Cenis. Il était dès 1938 fort bien placé aux abords de Modane pour atteindre le col ou le tunnel. Le franchissement du Mont Cenis s'est réalisé pendant la guerre, causant une attaque généralisée des champs de pommes de terre du Piémont, province par où débuta l'invasion de la péninsule.

Après cela, il est facile de comprendre que les sierras espagnoles, les monts d'Allemagne, les Karpates, le Caucase et l'Oural ne seront pour la Chrysomèle américaine que

des freins sans consistance ni durée, et qu'elle aura beau jeu pour atteindre la Pomme de terre dans tous ses habitats, ou presque.

S'il est hors de doute que la seule propagation naturelle explique toute l'histoire de ses conquêtes en Amérique du Nord et en Europe occidentale, cela ne veut pas dire que les transports accidentels ne jouent aucun rôle et qu'il faille les négliger tout à fait. Il est notamment incontestable que le va et vient au creux des vallées étroites, sur les voies ferrées et les routes, de toutes sortes de véhicules susceptibles de happer au vol les insectes ailés a pour effet d'augmenter les chances et d'abrégier le temps du passage des hauts reliefs.

Concluons que la fécondité du Doryphore, son aptitude au vol et sa prédilection pour la Pomme de terre cultivée rendent ses progrès inéluctables. L'acclimatation de ses principaux ennemis naturels américains, entreprise par nous il y a 15 ans, ne sera jamais qu'un palliatif; il faut lui opposer des traitements réguliers qui rendent sa présence compatible avec de bonnes récoltes, en attendant que les génétistes aient doté la culture d'une gamme de variétés nouvelles susceptibles de braver à la fois l'Insecte et les maladies, tout en répondant le mieux possible aux goûts et aux besoins des consommateurs.

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## FRANKLINIELLA TENUICORNIS UZEL (Thysanoptera) ALS INTRAFLORALER SCHÄDLING AN GERSTE

Von Veikko Kanervo

Bekanntlich erreichen die Thysanopteren als Schädlinge vieler Kulturpflanzen, insbesondere der Getreidearten, eine nicht geringe wirtschaftliche Bedeutung. Einige von ihnen rufen durch ihre Saugtätigkeit u. a. totale Weissährigkeit hervor, andere wiederum in der Hauptsache partielle Weissährigkeit, Taub- oder Leerkörnigkeit, Weissflissigkeit, an Halm und Blättern auch Weissfleckigkeit, Torsionen, Schrumpfund u. dgl. m. *Frankliniella tenuicornis* Uzel beteiligt sich bei manchen Getreidearten an der Entstehung sämtlicher hier aufgezählter Schädigungsarten; als typischste und wichtigste Schädigungsweise dieser Thysanoptere hat sich aber unter denjenigen Verhältnissen, die den nachstehend erörterten Untersuchungen in Finnland zugrunde gelegen haben, die Hervorrufung von Taubkörnern oder Leerkörnigkeit als Folge des Ansaugens der Samenanlage und des in Entwicklung begriffenen Samens (Kornes) ergeben. Die übrigen Schädigungsweisen der Art sind recht eingehend u. a. von E. Reuter (1900, 1901, 1902) und Y. Hukkinen (1934) in Finnland sowie E. Johansson (1938 und 1946) in Schweden untersucht worden, der intrafloralen Schädigung scheint hingegen keine grössere Beachtung beigemessen worden zu sein.

Schon Reuter (1901 und 1902) stellte fest, dass die Art bei den von ihr befallenen Pflanzen Leerkörnigkeit oder partielle und auch totale Weissährigkeit sowie Weissflissigkeit hervorruft. Johansson (1938) hat gefunden, dass in Südschweden bis zur Reife des Weizens zwei Generationen auftreten. Die Art soll vorliegenden Angaben gemäss vornehmlich am Weizen und am Roggen leben, greift aber auch Gerste, Hafer, Wiesenfuchsschwanz, Timothe und gewisse andere Wiesengräser an. Ihre Entwicklung und Lebensweise sind aber bisher dermassen mangelhaft beschrieben worden, dass es motiviert erscheint, sie hier in ihren Hauptzügen zu erörtern, ehe ich dazu übergehe, die Art der intrafloralen Schädigung selbst zu schildern. Die betreffenden Untersuchungen sind von mir im Anschluss an die Arbeiten der Schädlingsabteilung der Landwirtschaftlichen Versuchsanstalt Finnlands in der Hauptsache schon im Jahre 1931 in Ylistaro ausgeführt worden, ich habe sie aber auch später, bis in die letzte Zeit hinein, ausgebaut und komplettiert. Dabei habe ich von Professor Yrjö Hukkinen manchen wertvollen Rat empfangen dürfen.

In Ylistaro, einem auf 63° nördlicher Breite gelegenen Ort im westlichen Mittelfinnland, wurde in bezug auf das Auftreten der verschiedenen Generationen im Jahre 1931 folgendes beobachtet. Überwinterte Imagines waren am Roggen Ende Mai reichlich zu finden, und auch Eier gab es zu dieser Zeit schon recht viel. Auch am Wiesenfuchsschwanz wurde die Art mässig reichlich gefunden, am Timothe dagegen nur wenig. Die Eiablage war am intensivsten in den ersten Tagen des Juni, schon bevor der Roggen in die Ähre geschossen war, was in der Zeit vom 8. VI. bis etwa 16. VI. geschah, und dauerte dann bis zum 20. Juni fort. Die Eier wurden in das Blattgewebe eingesenkt, und zwar beschränkte sich ihr Vorkommen nicht einzig auf die nahe beim Häutchen gelegenen basalen Blattabschnitte, wie es in den Bildern 1 und 2 zu sehen ist.

Die ersten Larven erschienen im Anfang des Juni. Sie hielten sich zunächst an den Blattgründen und in dem geräumigen obersten Teil der obersten Blattscheide, doch waren Larven auch in den untersten Blattscheiden reichlich zu finden. Nach dem

Hervorbrechen der Ähren siedelte ein grosser Teil der Larven auf diese über, fortgesetzt aber wurden zahlreiche Larven in der obersten Blattscheide, doch nur noch wenige in den untersten gefunden, die sich bereits erhärtet hatten und zugleich eng geworden waren. Am Winterweizen hielten sich die Larven nach wie vor zur Hauptsache am Grunde der noch saftigen und weichen Blätter auf. Bald nach vollendeter Ährenbildung des Roggens (etwa 15.—20. VI.) nahm die Zahl der *Frankliniella*-Imagines an dieser Pflanze rasch ab, in der Hauptsache als Folge des um Diese Zeit eintretenden Todes der überwinterten Tiere. Imagines der neuen Generation waren dabei noch nicht erschienen, doch schon beim Ausgang des Monats (29. VI.) stellten sich die ersten ein, so dass man ihnen in den ersten Tagen des Juli schon reichlich begegnete. Sie fühlten sich jedoch nunmehr am Roggen nicht mehr wohl, dessen Gewebe ihnen offensichtlich schon zu rauh geworden waren, sondern siedelten insbesondere auf Gerste und Hafer über. Am Winterweizen dagegen verweilten die Imagines der neuen Generation in der Fortsetzung in ziemlich grossen Scharen, und auch noch die folgende, zweite Generation lief ihre ganze Entwicklung an derselben Wirtspflanze durch. Die Gewebe des Weizens waren also den Tieren offenbar dauernd zuträglich.

An Gerste und Hafer, die in der Nähe des Roggens und des Winterweizens standen, wurden noch am 29. VI. überhaupt keine Frankliniellen gefunden. Am 3. VII., als die Saat bereits 15—20 cm hoch war, hatten sich an den genannten Pflanzen bereits einige Imagines eingefunden, und am 5. VII. waren solche schon reichlich und an den Blattgründen auch Eier in einiger Zahl zu finden. Die Zahl der Imagines kulminierte an der Gerste etwa um den 15.—20. VII., und das ziemlich reichliche Auftreten dauerte dann bis zum Ende des Monats an. Am Hafer waren ausgewachsene Imagines am reichlichsten beim Übergang vom Juli zum August zu finden. Die Tiere lebten hauptsächlich an den Blättern, doch auch in der obersten Blattscheide, wo auch Eiablage sowohl in die Scheide selbst als in die noch eingeschlossene Ähre stattfand. Larven begannen etwa um den 10. VII. aufzutreten. Diese begaben sich alsbald von den Blattgründen in die oberste, die immerfort noch nicht ausgebrochene Ähre umschliessende Blattscheide. Nach dem Ausbrechen der Ähre, was etwa um den 15. VII. geschah, hielten sich die Larven am liebsten in der Ähre auf, wo sie zwischen den Ährchen und in grosser Anzahl in den Blüten lebten, diese arg beschädigend. Die Eiablage dieser Generation dauerte an Gerste bis zum Ende des Juli fort, und Larven waren etwa bis zum 20. VIII. zu finden. Die Entwicklung hatte einen ziemlich raschen Verlauf. Schon von den ersten Tagen des August an, am reichlichsten jedoch etwa um den 15.—20. VIII., fanden sich Imagines der zweiten Generation ein. Diese fühlten sich nur eine kurze Zeit in der bereits heranreifenden Gerste wohl und siedelten alsbald auf Pflanzen jüngeren Stadiums, wie auf junge Sprosse von Wiesenfuchsschwanz, Timothee, Hafer und Gerste über, denen man zerstreut in der nächsten Umgebung begegnete. Hier machte sich, wie es vorgenommene Zuchtversuche erwiesen, ein kleiner Teil der Weibchen der zweiten Generation im Anfang des August an die Eiablage. Ein Teil der Eier wurde jetzt dabei an Gerste und Hafer in die Spelzen — sowohl die Kelch- als Blütenspelzen — und auch in die Grannen abgelegt, der grösste Teil jedoch stets in die basalen Blattabschnitte. Kein einziges Mal während des ganzen Sommers habe ich Eier im Korn selbst gefunden. In Haferfeldern, die sich wegen der späteren Reife des Hafers länger, bis in die letzten Tage des August, grün erhalten, gediehen die Imagines bis zum Ende des genannten Monats. Zu der Bildung einer dritten Generation kam es offenbar nur bei einem ganz kleinen Teil des Bestandes.

Im September, nach der Aufkeimung des Roggens, siedelten die *Frankliniella*-Ima-

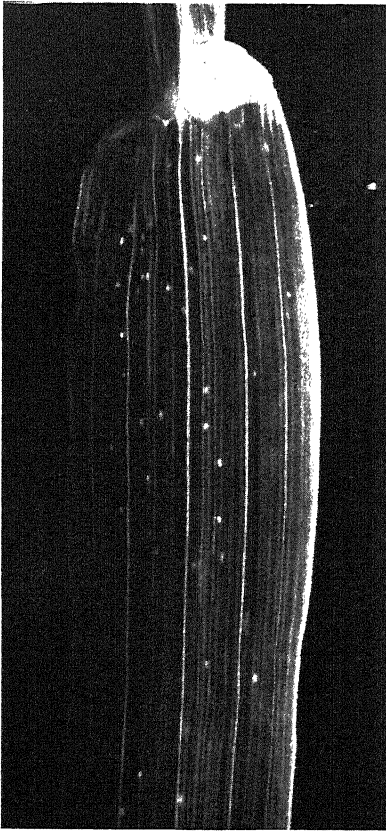


Bild 1. Eier von *Frankliniella tenuicornis*. Jeder weisse Punkt bezeichnet den Platz eines. — Orig.

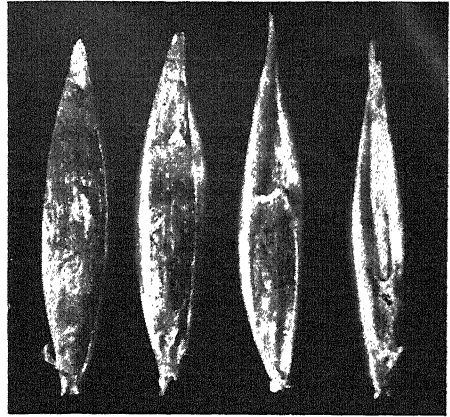


Bild 3. Verschiedengradige intraflorale Schädigungen durch *Frankliniella tenuicornis*-Larven bei den Gerste. Rechts ein völlig zerstörtes Korn, nach links davon eine abnehmende Reihe bis zum beinahe unverzehrten Korn. — Orig.

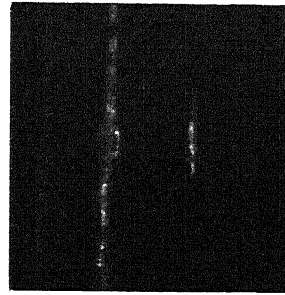


Bild 2. Ein vertikaler Schnitt durch das Blatt enthüllt uns das in das Blattgewebe versenkte, länglich wurstförmige Ei von *Frankliniella tenuicornis*. — Orig.

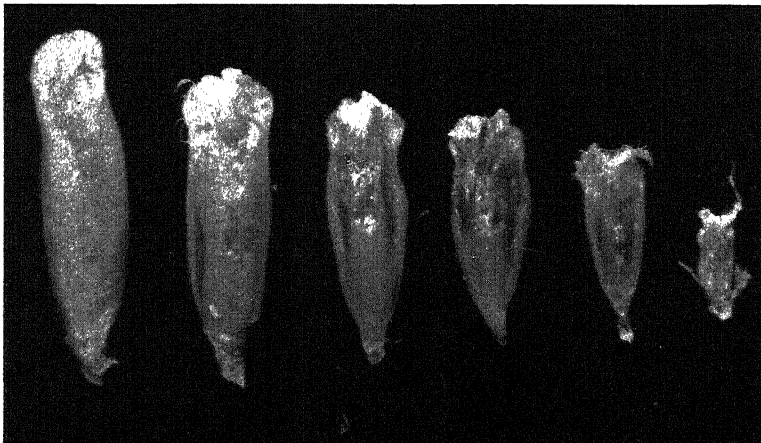


Bild 4. Eine ähnliche Reihe wie im Bild 3, hier aber mit sorgfältig geschälten Körnern. An den Ansaugstellen zeigt die Kornoberfläche seichte, sich alsbald bräunende Vertiefungen — Orig.

gines auf die Roggensaart über, wo man ihnen bis zum Ende des Monats reichlich und in einiger Anzahl auch noch im Anfang des Oktober begegnete. Hier wurden im Herbst weder Eier noch Larven gefunden, die durch die Imagines hervorgerufenen Schädigungen waren aber am Ende des September auffällig.

Den Angaben des Schrifttums (u. a. Reuter 1902 und Johansson 1938) gemäss bevorzugt die Art besonders Roggen, Weizen und Gerste. Tabelle 1 zeigt die festgestellte Reichlichkeit von *Frankliniella tenuicornis* in Finnland an einigen Getreidearten auf Grund von Kescherproben (2+30 Schläge) im Jahre 1931. Überwinterter Imagines waren also am reichlichsten am Roggen, bedeutend weniger dagegen an Winterweizen, Wiesenfuchsschwanz und Timothe zu finden. An Gerste, Hafer und Sommerweizen, trat diese Generation in kaum erwähnenswertem Ausmass auf, was davon herrührte, dass diese Getreidearten beim Eintritt der hauptsächlichlichen Flugzeit dieser Generation noch nicht aufgesprossen waren. Neue Imagines (erste Generation) wurden am reichlichsten an der Gerste, sehr reichlich am Hafer, ziemlich reichlich am Sommerweizen, bedeutend weniger an Winterweizen und Wiesenfuchsschwanz und sehr wenig an Roggen und Timothe gefunden. Aus den Eiern dieser Tiere hervorgegangene Imagines der zweiten Generation sah man an der Gerste nur während einer kurzen Zeit reichlich, am Hafer etwas länger und dann später im Herbst an der aufgesprossenen Roggensaart. Es erweist sich also, dass die Art besonders Gerste und Roggen, recht erheblich auch Hafer und Sommerweizen bevorzugt. Die Reichlichkeitsentfaltung ist jedoch weitgehend vom Entwicklungszustand der Pflanzen abhängig, denn die Art beforzugt die grünen und noch weichen Pflanzenteile.

Wie oben bereits angedeutet wurde, ruft die Art an den Pflanzen sehr verschiedenartige Schädigungen hervor. Am sämtlichen Nahrungspflanzen entstehen als Folge des Ansaugens helle Flecke an Blättern und Blattscheiden. Diese Schädigungsweise erreichte ihr ärgstes Mass an der Gerste um den 15.—20. Juli, als die Blätter stark zusammengeschrumpft und zu einem grossen Teil entfärbt vorgefunden wurden. Auch die Larven rufen in gewissem Umfang ähnliche Schädigungen hervor. Die schon vor dem Ausbrechen der Ähre in die oberste Blattscheide eingedrungenen Imagines saugen vor allem den oberen, im erweiterten Teil der Blattscheide gelegenen Ährenabschnitt an, einigermassen auch den unteren, die Ährchen und Ährchenstiele extrafloral angreifend, so dass schliesslich zumal an Gerste und Sommerweizen, in gewissem Umfang auch an Roggen und Winterweizen die ganze Ähre welkt und sich entfärbt, und die Grannen sich zu gekräuselten Fäden umbilden. An jeder Schädigung beteiligen sich auch die Larven, doch ist ihre hauptsächlichliche Schädigungsweise zumal an der Gerste (an den übrigen Getreidearten weniger) eine intraflorale. Die Larven dringen in die Ährchen schon vor dem Blütebeginn, zum Teil während der Blüte und zum Teil auch später ein. Im ersteren Fall werden die Samenlagen binnen kurzer Zeit von den Larven ausgesogen und gelangen nie zur Entwicklung. Dies war die häufigste Art der Schädigung im Jahre 1931, denn die Ähren waren schon beim Aufblühen der Ährchen ausserordentlich reich von *Frankliniella*-Larven befallen. Die später in die Ährchen eingedrungenen Larven saugen die schon in Entwicklung begriffene Samenanlage an, und ist das Korn dann noch weich, so erfolgt oft seine Verkümmern. Hat aber seine Erhärtung bereits eingesetzt, so ist Missbildung und auch bestenfalls Herabsetzung der Keimfähigkeit die Folge. Sehr ähnlich ist die Schädigungsweise bei *Haplothrips aculeatus* (Brummer 1939) an Roggen.

Es ist zu bemerken, dass die intraflorale Schädigung an der

Gerste am reichlichsten, ziemlich reichlich auch am Sommerweizen, spärlich dagegen am Winterweizen und sehr spärlich an Hafer und Roggen war. Beim Hafer drangen die Thysanopterenlarven meistens nicht weiter als bis zum Zwischenraum zwischen den Kelch- und Blütenspelzen ein.

Es ist schwierig, den Einfluss der durch *Frankliniella tenuicornis* hervorgerufenen extrafloralen Schädigung auf die Ernteerträge auch nur annähernd anzugeben. Bei der intrafloralen Schädigung wird es dagegen wohl möglich, und zwar durch Zählung der zerstörten Samenlagen bzw. Körner. Tabelle 2 zeigt die Ergebnisse einer bei den verschiedenen Sorten einer Gerstenkultur durchgeführten Analyse (60 Ähren von jeder Sorte). Daraus ist erstens zu ersehen, dass die vier- und sechszeiligen Gersten weit stärker als die zweizeiligen angegriffen waren. Bei den ersteren wurden nämlich durchschnittlich 13 % der Körner völlig zerstört und 15,4 % weniger arg beschädigt vorgefunden; bei den zweizeiligen Gersten waren die entsprechenden Werte 4,9 und 5,1 %. Doch muss bemerkt werden, dass der Befall bei der am meisten bevorzugten zweizeiligen Sorte etwas stärker als bei den am wenigsten bevorzugten vierzeiligen war. Dies deutet also darauf hin, dass auch Sorten mit der gleichen Zeilenzahl in verschiedener Weise von den Tieren geliebt werden. Die Unterschiede schienen sich teilweise von der zeitlich verschiedenen Entwicklung der Sorten herzuleiten, doch wirken hier offenbar auch andere Faktoren ein, wie Geschmack und Beschaffenheit (Weiche, Härte) des Gewebes, u. dgl. m. Bei der am schlimmsten befallenen Sorte waren 20 % der Körner vollständig zerstört, und zählt man dann noch die in recht beträchtlicher Anzahl vorhandenen weniger stark beschädigten Körner hinzu, so steigt der Ertragsverlust im ganzen noch erheblich höher. Besonders hervorzuheben ist ferner, dass an Stellen, wo das Getreide sich gelagert hatte, die Angriffe der Thysanoptere einen bedeutend stärkeren Grad als im stehenden Getreide erreichten. Als Beispiel möge ein mit Vega-Gerste bestelltes Feld genannt werden, wo an Stellen mit niederliegendem Getreide etwa 51 % der Körner völlig oder fast völlig beschädigt waren, während der entsprechende Wert im stehenden Getreide nur etwa 26 % betrug. — Um ein Bild zu geben von der Häufigkeit des Schadens in der Provinz Pohjanmaa im Jahre 1931 möge mitgeteilt werden, dass der relative Betrag der als Folge der Angriffe durch *Frankliniella tenuicornis* leeren Körner in 32 untersuchten Ortschaften um den Mittelwert von etwa 12 % herum zwischen 2 und 30 % wechselte.

Aus anderen Jahren liegen keine so detaillierten Ermittlungen über die Schädlingstätigkeit der *Frankliniella tenuicornis* vor, doch ist aus einem im übrigen ziemlich umfangreichen Beobachtungsmaterial zu entnehmen gewesen, dass die Art ganz allgemein bei der Gerste Leerkornbildung hervorruft, selten jedoch in dermassen bedeutendem Umfang wie im Jahre 1931 in der Provinz Pohjanmaa.

Die oben relatierten Untersuchungen haben erwiesen, dass *Frankliniella tenuicornis* zu den hervorragenden Schädlingen der Gerste in Finnland gehört, der zumal im Larvenstadium durch intraflorales Aussagen der Samenanlagen bzw. des in Entwicklung begriffenen Kornes bedeutende Schäden verursacht. Die Art erzeugt in Finnland gewöhnlich zwei Generationen, von denen die erste (die aus den überwinterten Tieren hervorgegangene) zur Hauptsache am Roggen, weniger reichlich an Winterweizen, Wiesenfuchsschwanz, Timothe u. dgl. m., die zweite wiederum, deren

Bedeutung als Schädling der Gerste die grösste ist, vor allem die Gerste und den Hafer bewohnt. Aus einem Teil des Bestandes entwickelt sich auch eine dritte Generation, doch geht dieser jede nennenswerte wirtschaftliche Bedeutung ab.

Tabelle 1. *Thysanopteren (Imagines) in den Kescherproben des Jahres 1931.*

<i>Frankliniella tenuicornis</i> Uzel									
	27/5	8/6	15/6	10/7	15/7	23/7	1/8	10/8	24/8
Roggen	287	1183	426	55	9	5			
Winterweizen	1	29	44	37	56	103			
Wiesenfuchsschwanz	43	6	11	60	103	115			
Timothe	4	18	21	199	6	7			
Hafer				114	1095	1224	1764	948	565
Gerste				502	3650	3110	228	82	—
<i>Limothrips denticornis</i> Hal.									
Roggen	50	101	83	41	34	17			
Winterweizen	—	3	1	5	17	22			
Wiesenfuchsschwanz	11	64	48	—	6	5			
Timothe	—	13	3	1	—	2			
Hafer				19	—	15	43	26	—
Gerste				15	82	45	3	2	—
Sonstige <i>Thysanopteren</i>									
Roggen	82	13	79	32	18	26			
Winterweizen	17	32	5	28	31	40			
Wiesenfuchsschwanz	616	1785	873	794	1050	1098			
Timothe	34	179	8	44	84	80			
Hafer				61	82	114	12	5	—
Gerste				134	60	42	—	3	—

Tabelle 2. *Ausmass der durch Frankliniella tenuicornis hervorgerufenen intrafloralen Schädigung bei verschiedenen Gerstensorten im Jahre 1931.*

		Vollständig zerstörte Körner		Teilweise beschädigte Körner		Gesunde Körner		Zusammen	
Sorte		St.	%	St.	%	St.	%	St.	%
6- und 4-zelige Sorten	T 0615	442	20.0	509	23.0	1265	57.0	2216	100
	Vega	380	16.6	415	18.5	1497	64.9	2292	100
	T 0381	348	12.3	402	14.2	2088	73.5	2838	100
	Olli	206	8.5	257	10.7	1943	80.8	2406	100
	MK 030	224	7.5	318	10.6	2448	81.9	2990	100
Zweizeilige Sorten	Uurainen	104	9.8	116	11.0	836	79.2	1056	100
	Franken	68	5.5	62	5.0	1104	89.5	1234	100
	Moravia	62	4.3	60	4.2	1304	91.5	1426	100
	MK 02	46	3.6	53	4.2	1173	92.2	1272	100
	Voitto	38	3.1	45	3.7	1131	93.2	1214	100
	Halikko	36	2.8	32	2.5	1200	94.7	1268	100

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## THE ECOLOGICAL INVESTIGATION CONCERNING THE ENVIRONMENTAL CLIMATIC CONDITION OF THE RICE LEAF-MINER, *AGROMYZA ORYZELLA* MATSUMURA

By *Mutsuo Kato*

The rice leaf-miner, *Agromyza oryzella*, distributes in the west half of Hokkaido, the most part of North-East of Honshu and Hokuriku of the same. The 1st generation of this insect grows in the nursery and the 2nd generation in the paddy field. In this paper the relation between the population density of this insect and its environmental meteorological condition was dealt with.

### *Local types of the population density of the rice leaf-miner*

The experiments were conducted at several places, i.e. Akita in Akita Prefecture, Tateoka and Fujishima in Yamagata Prefecture and Kurobe, Toyama and Tonami in Toyama Prefecture. The population density was estimated in paddy fields of direct sown rice, specially prepared for the present study, because the population density of this insect may be disturbed in the course of progression from the 1st generation into the 2nd one by transplanting rice plants from the nursery to the paddy field. Two types of population density were obtained in this study.

1. Population density of the 1st generation exceeds that of the 2nd. This type is seen typically at Fujishima in Yamagata Prefecture.

2. The 2nd generation exceeds in population than that of the 1st. This is observed at Akita.

Thus the further investigation was conducted at two representative localities, Fujishima in Yamagata Prefecture and Akita in Akita Pref. At Akita the larvae belonging to the 2nd generation are more numerous than those belonging to the 1st, but the matter is contrary at Fujishima. The environmental resistance for the minor is not strict at Akita, but is severe, especially for the 2nd generation, at Fujishima. Concerning the 2nd generation, the number of larvae per one stump is 25—30 at Akita, and 20 or so at Fujishima; and the mortality is 24 % at Akita, and 52 % at Fujishima.

### *The environmental thermo-hygro relation measured at two localities*

The air temperature and the relative humidity were measured microclimatically in the period of the emergence of the said leaf-miner. It seems that the thermo-hygro relation of the environmental condition is similar in the said two localities, and thus it may be concluded that the thermo-hygro relation is not so important factor which controls the population density of the leaf-miner. It seems, however, that the environmental temperature is generally higher at Fujishima than at Akita, and therefore the environmental temperature must be inquired in order to clarify the limiting factor of the population density of the said insect.

### *The temperature limit of activity of the leaf-miner*

The experiments were conducted under the gradually rising temperature at the rate of 1° C. in every 4 minutes using the adult flies and larvae belonging to the 1st and 2nd generations. Here, no significant difference was recognized not only between data

obtained from the 1st generation and those from the 2nd, but also between data obtained at Akita and at Fujishima, and thus the results are tabulated in the following.

	Flies	Larvae
Slight movement .....	7.0—10.4° C.	4.4— 5.6° C.
Standing on feet .....	9.1—12.8	—
Crawling .....	16.2—17.2	12.9—16.8
Normal activity .....	—	17.2—20.1
Flying .....	19.3—19.9	—
Nervous .....	29.0—30.2	26.4—31.4
Falling down (Heat paralysis) ....	34.6—45.7	33.1—46.1
Death .....	40.9—46.7	42.4—46.5

Reliability 95 %

The optimum temperature zone of adult activity is in the range covering from 16.5° to 30.0° C. Therefore the normal activity is not observed below 15° and above 30° C., and the flying begins at about 20° C. In the case of the larval activity, resistance of temperature is seen below 14° and above 29° C. It seems therefore that the optimum temperature zone of activity of this insect is seen between 20° and 25° C., and thus it is conceivable that the said insect is adaptable to the fairly low temperature environment.

#### *The micro climatic environment of the leaf-miner*

The daily progress of the temperature of the mesophyll of the leaves in which the larvae of the flies live, the leaf surface temperature and the adjacent air temperature were measured by thermocouples.

At Akita, the temperature of the mesophyll is generally almost equal to the leaf surface temperature and the air temperature, and it is 1° C. or so higher than the other two only in the period covering from 10 a.m. to 4 p.m. At Fujishima, the leaf temperature is 1° C. or more higher than the other two already at 6 a.m., and 2° C. or more higher in the period from 10 a.m. to 4 p.m. The phenomena above mentioned are, of course, related to the macro-climate of two localities. At Akita, the morning calm is seen and thus the haze in the morning weakens the available solar radiant heat. On the other hand, these phenomena are not seen at Fujishima and thus the absorption of the solar radiant heat is observed already in the morning.

#### *The vertical distribution of the air temperature*

The vertical distribution of the air temperature in the nursery and the paddy field was measured in order to clarify the air temperature adjacent to the crown of the rice plant where the flies are living.

The 1st generation: —Akita—Fluctuation of the air temperature is in the range from 13° to 24° C., having the mode covering from 14° to 22° C. Fujishima—Temperature fluctuates from 8° to 28° C. and the mode of the daily fluctuation is in the range from 14° to 24° C. Thus, it is clear that the temperature is remarkably high at Fujishima. When the micro-environmental temperature of the leaf-miner and the temperature reaction of the said insect are taken into consideration, the optimum temperature environment for the activity of this insect is given at Fujishima, and thus the environment at Akita is too low in temperature for the same insect.

The 2nd generation: —Akita—The environmental temperature changes from  $18^{\circ}$  to  $27^{\circ}$  C. and the mode of fluctuating range is seen from  $19^{\circ}$  to  $26^{\circ}$  C. Fujishima—Fluctuation of the environmental temperature is seen from  $19^{\circ}$  to  $32^{\circ}$  C. and the mode of it is from  $20^{\circ}$  to  $26^{\circ}$  C. It is, therefore, easily recognized in the 2nd generation that at Fujishima the activity seems to be inhibited by the high temperature, and acceleration by the optimum temperature environment is given at Akita.

#### *Conclusion*

The environmental temperature is most effective upon the population density of the rice leaf-miner, and it may be therefore concluded that the local type of the emergence of this insect depends upon the locality of the temperature environment.

Here, the temperature reaction of the activities of this insect and the micro-environmental temperature, that is, the temperature of mesophyll of leaves in which the larvae live, must be inquired into.

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## *Anthonomus pyri* Koll AND ITS ATTACK ON PEARS IN THE NETHERLANDS

By D. J. Kuenen

*Anthonomus pyri* Koll (= *cinctus* Redt) is a weevil from Central and Western Europe. While it is found to attack mainly pears on the Continent and is consequently called l'Anthonome du Poirer, Birnenknospenstecher, Perebloesemkever etc., it seems to have been found mainly on apples in England and is there called the Apple Bud Weevil, but it occurs on pears there too.

Several articles have been published on this species by Jancke, Niklas, Bovey and others and my studies agree in most points with these. A detailed report on the results of these investigations and the subsequent excellent control will be published elsewhere. I want to draw attention here to two details which deserve special attention: firstly the extent of the damage and the difficulties encountered in estimating it, and secondly the number of weevils involved in the attack on the pear trees.

For those not well acquainted with this weevil a short survey of its biology will be given first.

The weevil deposits its eggs in the flowerbuds of pears in the autumn, beginning in September and going on until the end of the year. From these eggs the larvae hatch which feed on the green tissues inside the bud, and they are full-grown about the beginning of May. They pupate in the empty bud and the adult emerges towards the end of May. The weevil feeds for a short time and then aestivates on the pear tree until about the beginning of September when feeding recommences and oviposition begins.

The most obvious way of estimating the damage done by this weevil is by counting the number of buds which fail to open in the spring. This, however, leads to unreliable results. Firstly there are a number of buds which fail to open and which do not contain a larva of *A. pyri*; it is then not always easy to decide whether the damage is due to an egg of the weevil which has failed to hatch, to feeding of the weevil which also starts rotting of the bud, or to other causes not connected with this insect. Secondly there are a number of buds which rot and fall off during the winter, which fact also influences the results of an estimate made in spring.

What happens to the pear buds can best be shown by drawings (figs. 1—10).

Fig. 1 shows the weevil in its characteristic attitude when it feeds on the inner tissues of the bud.

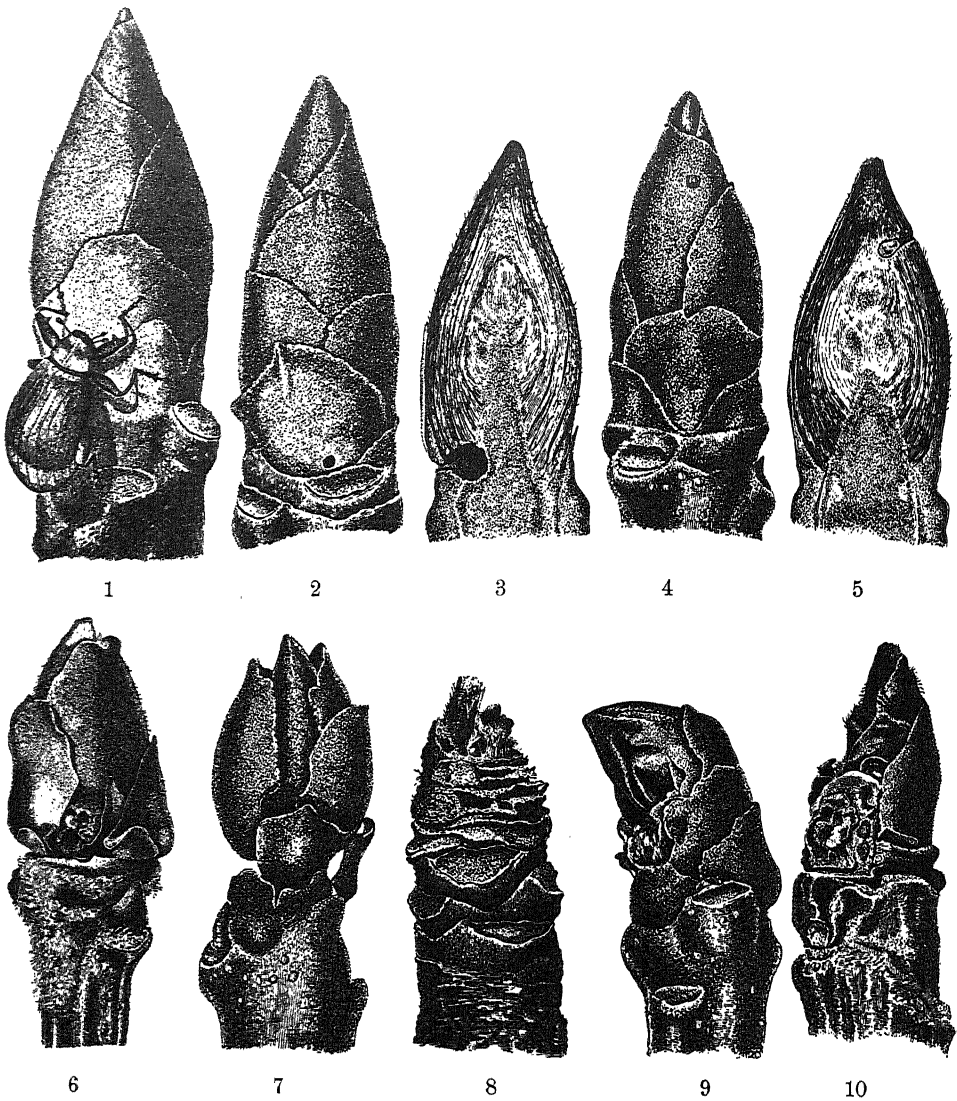
Fig. 2 shows the puncture made in the outer bud scale and fig. 3 the cavity in cross section.

Fig. 4 shows a bud in which an egg has been laid, the hole covered up with a quickly hardening drop of fluid from the accessory glands. Fig. 5 the same in cross-section.

Fig. 6 gives an idea of the first stages of rotting as frequently observed during the autumn and early winter. The outer scales are falling off, but the centre of the bud may still be green. This is quickly followed by the stage of fig. 7 where more scales have fallen off and the whole bud is already dead.

Finally nothing is left but a dead stump as shown in fig. 8.

If the feeding is done in a very early stage of development, that is in June, the buds either die entirely or at any rate shown misformations as in fig. 9 where the bud



itself was damaged and grew crooked, while in fig. 10 it apparently has been the tissue just under the bud which was damaged and which subsequently formed a callus, the bud developing only very poorly afterwards.

It may be clear from these figures that there is some variety in the damage done by the weevil and that for an accurate estimate of the number of buds killed it is necessary to make that estimate before the buds begin falling off.

The second point I want to discuss here is the question of the number of weevils which make up the population of a pear tree if it is being seriously attacked. It has been

assumed by Jancke that as the number of eggs per female is about 15—20, a severe attack on a pear tree is more due to an abundance of weevils than to the extent of the damage done by each weevil.

To investigate this problem further weevils were caught by beating in several orchards, and brought to the laboratory. There they were kept in petri-dishes and fed with fresh pear twigs ever other day. At the end of each two-day-period the number of feeding punctures and eggs deposited was counted. The following summary of the results may be given.

Of the 120 weevils studied 42 were males and 78 females.

42 ♂ in 756 days (the total for all the weevils) made 548 feeding holes = 1 hole in 1.4 days.

78 ♀♀ in 3299 days made 2863 feeding holes = 1 hole in 1.1 days.

78 ♀♀ in 3299 days deposited 623 eggs = 1 egg in 5.3 days.

The minimum egg-production was 1 egg in nearly 80 days, the maximum 15 eggs in 36 days or 1 egg in 2.4 days. The maximum number of eggs per female was 26 eggs deposited in 87 days.

As the period of activity is about 3 months we would arrive at a mean egg production per female of about 15 eggs, which agrees well with what other investigators have found.

Now the damage done may be calculated as follows.

The number of feeding punctures and eggs in total from these weevils was  $548 + 2863 + 623 = 4034$  punctures. This was done in  $3299 + 756 = 4055$  days. This means very nearly one puncture per weevil per day or, over a period of 3 months about 90 punctures for each weevil.

Now the next question is whether all these buds are actually killed. To find out whether this actually was the case a number of buds were marked in October and November as being damaged by feeding punctures and others damaged by oviposition. All these buds were inspected the following spring and it was found that only 3% of the buds damaged by feeding punctures had survived and nearly 20% of those in which an egg had been deposited. As the number of feeding punctures is more than 5 times as great this means that about 5% of the total number survive. This has to be subtracted from 90 leaving about 85 buds killed per weevil.

In a certain case the percentage of buds damaged was found to be 80% while the total number of fruit buds was 1500. This means that on this medium sized tree about 1200 buds had been damaged at 85 per weevil which gives us the result of 15 weevils on that particular tree.

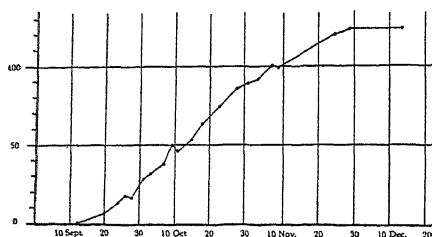
These trees were also beaten and we caught 5 weevils in one time. It does not seem improbable that only one third of the beetles were caught, some falling beside the screens, others clinging to the buds where they are firmly lodged when at rest.

These results show clearly that the number of eggs deposited is no measure for the damage and that indeed, contrary to Jancke's opinion, it is certain that the damage done by *Anthonomus pyri* is not so much due to the large numbers of weevils present on the tree as to the large numbers of buds killed by each of the weevils.

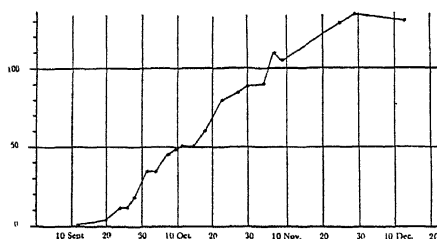
Now one important assumption has been made in this discussion which has yet to be proved, namely that the number of weevils on the tree remains constant during the three months of oviposition, and that the population consists of the same weevils during that time.

That the number of weevils is very constant can be shown by the very regular increase of the numbers of eggs and punctures on the trees (fig. 11). There also appears to be very little influence of the climate, as the fluctuations in temperature, the heavy showers or periods of sunshine do not in any way show in these graphs. In agreement with this we found weevils walking about on wet trees and even during rainfall, while other experiments, which I will not discuss here, show that only temperatures near zero retard the rate of oviposition significantly, and that even at zero some eggs may be deposited.

Fig. 11.



*Increase of the number of eggs + feeding holes per 100 buds during the autumn 1946 (var. Précoce de Trévoux).*

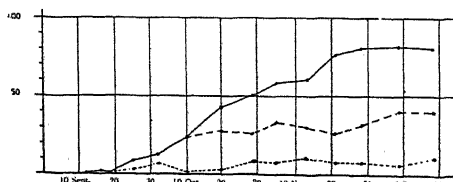


*Idem (var. Clapp's Favourite).*

Finally it can be shown that there is very little migration from one tree to the other during this period. If we spray a tree with DDT, all the weevils are killed and no further damage is done to the buds. The trees then apparently remain free from weevils for the rest of the season as the dotted lines in fig. 12 show.

Now this means that either the DDT remains active during that whole period of three months, or that the weevils do not migrate onto these trees. Apart from the general experience that DDT remains toxic on trees for three weeks at the utmost the following experiment throws some further light on this problem.

Fig. 12.



*Curve of egg numbers + feeding holes per 100 buds on an untreated tree (upper line), on a tree sprayed late (10 October, middle line) and on a tree sprayed early (18 Sept. lower line), in a heavily infested orchard.*



Twigs were cut from untreated trees, from trees which had been sprayed in the last 24 hours and from trees which had been treated 4 weeks previously. Bits of these twigs were put into petri-dishes and a few weevils added to them.

The weevils died on the recently treated twigs, lived on the untreated twigs and also lived, apparently quite normally, on the trees which had been treated 4 weeks earlier. This means that weevils migrating onto those trees in the field would also remain alive, feed and oviposit as they did in the laboratory. As this was not the case it must be assumed that the weevils did not migrate. This means that the population on any tree is extremely independent of other trees and therefore constant in composition.

Further proof of this can be found in the fact that a part of an orchard treated one year will remain practically free from weevils the next year too, while other, untreated parts may be teeming with them.

This last fact makes control, which has been worked out by several authors independently, very effective.

An application of DDT as soon as the first punctures are found may reduce the infestation from 60 of 80 % to 1—3 %. It will take the weevil several years to build up its population again to a dangerous level as surrounding orchards where no control may have been practised, add only very little to the increase of numbers.

The cost of spraying can therefore be calculated over several years which makes this control one of the most economic that has been worked out in the last years.

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## THE RICE LEAF-MINER: SOME OBSERVATIONS ON ITS ECOLOGY AND EXPERIMENTS ALONG THE CONTROL MEASURES

By Satoru Kuwayama

### Introduction

Among more than one hundred and ninety species of the rice insect-pests hitherto known in Japan, the rice leaf-miner (*Agromyza oryzae* Munakata)<sup>1</sup> is more serious one, following to the rice borers (*Chilo simplex* Butler and *Schoenobius incertellus* Walker), rice plant-hoppers (*Sogota furcifera* Horváth, *Delphacodes striatellus* Fallén and *Nilaparvata lugens* Stål), rice leaf-hoppers (*Nephotertix bipunctatus cincticeps* Uhler and *Deltocephalus dorsalis* Motschulsky), rice leaf-beetle (*Lema oryzae* Kuwayama), rice bug (*Scotinophara lurida* Burmeister), etc. Though the rice leaf-miner seems to be confined to the north temperate region in Japan<sup>2</sup>, from the Kamikawa district of Hokkaido in the north to the Toyama Prefecture of Honshu in the south ranging from about 36.5° N to 44° N in latitude, its feeding on the rice-leaves causes noticeable injury, and it often surpasses that of all other rice pests, especially in the northern parts in which the duration of the growth of rice plant is shortened. A study of this important insect was undertaken in 1941 by our Experiment Station, in cooperation with many research workers of the Central, Akita, and Yamagata Agricultural Experiment Stations. Some noteworthy results of our studies on this insects and experiments along its control, which continued through 1947, are abstracted in the following lines.

### A Brief Account of Seasonal History and Habits

According to our observations in Hokkaido there are one to three generations annually. The adults begin to emerge in the end of May or early June from the puparia which hibernated in the shallow part of soil or within the stubbles, both in paddy field. The last appear as late as the end of June. Table 1 and Figure 1 show the daily emergence records of breeding experiments in spring with the hibernant puparia for the two seasons.

The date and peak of emergence are different between both years, primarily due to weather conditions, and these records correlate very closely with field observations. The adults assemble in paddy field or in nursery, being very active on warm and calm daytime. The female makes many short scratches in the rice leaves with her ovipositor, then turning about, and sucking the juice from the host, and oviposition

<sup>1</sup> In 1910 Munakata (11)\* published a paper on the morphology, ecology, parasites, control measures, etc. of the rice leaf miner, under the name *Oscinis oryzae* Mats., based on his studies in the Aomori Prefecture. It is presumably the earlier literature. Although Matsumura (10) proposed another name *Oscinis oryzella* to this species in 1915, *O. oryzae* of Munakata must be retained in accordance to the International Rules of Zoological Nomenclature, as there is no description of *O. oryzae* by Matsumura. The generic position of this species may undoubtedly be transferred from *Oscinis* to *Agromyza*.

<sup>2</sup> The distribution of this species other than Japan is unknown. Hendel (1), however, described a rice leaf-miner from Nikolsk-Ussurijsa of East Siberia as new to science under the name *Agromyza oryzae*. It is closely allied to our species, but the discussion on the relation of both species may not be extended in this paper.

\* Reference is made by number (italic) to Literature cited, page no. 671.

Table 1. Emergence of adult of the rice leaf miner at Kotoni, near Sapporo, 1943 and 1945

1943				1945			
Date		No. of adult emerged	Mean temperature	Date		No. of adult emerged	Mean temperature
			C°				C°
May	31	1	16.6	June	8	1	11.2
June	1	1	18.0		9	0	12.1
	2	8	18.3		10	0	12.9
	3	14	15.8		11	8	11.7
	4	21	15.4		12	13	13.2
	5	29	17.0		13	21	11.7
	6		15.7		14	28	10.3
	7	23	16.7		15	41	14.1
	8		18.3		16	38	12.3
	9	31	19.1		17	65	11.9
	10	15	19.4		18	13	10.3
	11	8	14.8		19	11	11.3
	12	4	15.4		20	14	12.0
		3			21	8	12.8
					22	6	12.5
					23	3	14.8
Average of daily temperature		May 1—10	11.3	Average of daily temperature		May 1—10	7.6
		May 11—20	8.9			May 11—20	7.6
		May 21—30	12.8			May 21—30	9.9
						June 1—10	11.8

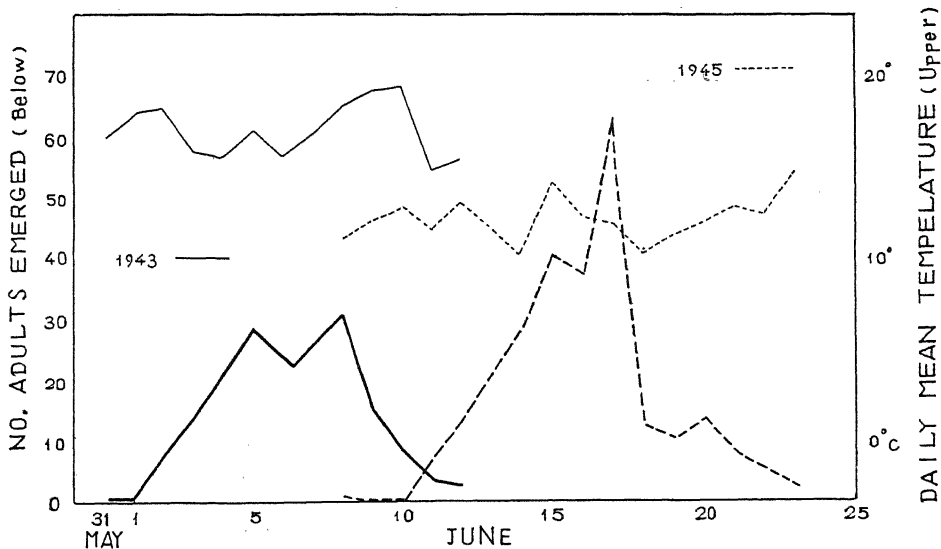


Fig. 1 — Seasonal emergence of adults from the hibernated puparia, at Kotoni, 1943 and 1945.

takes place by inserting the eggs singly in the top part of the leaves. Such a leaf, later, shows a speckled appearance, but the scratches and egg punctures are hardly distinguishable to the naked eye, unless with the aid of a magnifying glass. Within 6 days of incubation period, the larva hatches and immediately commences to mine the leaf, proceeding always downward. In form the mine is linear at first, enlarging rapidly the width, and turns to an irregular blotch. The colour of the mine is white or pale green at first, but changes afterwards to brown or dirty ochreous colour. The size and shape of the mine are considerably different, according to generation, size of leaf, or many other conditions. Data obtained from 46 individuals are given in Table 2.

Table 2. *Size of mines by the rice leaf miner, at Ono, near Hakodate, on July 18, 1944*

Item	Mean	Maximum	Minimum	Range
	mm	mm	mm	mm
Length	87.7	115.0	63.0	52.0
Broadest width	5.5	9.0	3.0	6.0

The larval life occupies from 10 days to fortnight, and just before pupation the larva usually escapes from the mine and pupates on the upper or under surface of the leaf or on the sheath, but sometimes pupation occurs in the mine. Requiring 7 to 18 days for the pupal period, the majority of the puparia are transformed into the adult flies of second generation, but partially the puparia enter into the hibernating states. The emergence of these adults may occur from late June to early July or later. Table 3 gives data regarding the emergence record of second generation in our indoor breeding.

Table 3. *Emergence of adult of the rice leaf miner at Kotoni, near Sapporo, 1942*

Date	No of adult emerged	Mean temperature	Date	No of adult emerged	Mean temperature
		C°			C°
June 30	1	18.1	July 9	0	21.8
July 1	0	19.1	10	0	20.8
2	3	21.3	11	0	18.6
3	4	21.5	12	0	18.2
4	15	23.3	13	0	18.4
5	5	20.3	14	0	17.9
6	7	23.6	15	0	16.6
7	2	23.0	16	1	16.6
8	0	21.5			

Material collected at Nagayama, near Asahigawa, on June 25, 1942.

The larvae of second generation appear abundantly during the middle of July, and almost pupate by the end of the same month. The majority of these puparia fall to the ground and remain in this condition until the next spring, except that a few puparia are transformed into the adult flies. These flies emerge in early August, and the injuries by third generation may be seen during the end of August and the middle

of September on late sowing rice plants or *Zizania latifolia* Turcz., which is only a wild host plant in Hokkaido, accordingly as a rule they are not practically important.

*Hibernant and Non-hibernant Types of the Puparia*

It is most interesting and noticeable that the hibernant puparia in each generation are quite different from the non-hibernant ones not only on the morphological characters but also on the ecological characters. This fact was first pointed out by Yabe (14) in 1937 and observed in detail by the author<sup>3</sup> (6, 9) from 1943 onward. Comparison of two types of the puparia is given as follows:

1. Difference of the morphological characters of both types.

*Hibernant puparium*

Dull black, rarely brownish black in colour; strongly convex dorsad; dorsal protuberance of the 4th segment very weak than that of the 5th, while the segments from 5th to 9th with keeled protuberance dorsally; somewhat concave at the ventral surface; anterior spiracles rather small.

*Non-hibernant puparium*

Pale greenish brown, brown or dark brown, rarely blackish in colour to a part or on the whole, glossy; moderately convex dorsad; dorsal protuberance of the 4th segment similar to that of the 5th, and the segments from 5th to 9th swelling dorsad, comparatively flattened at the ventral surface; anterior spiracles rather large.

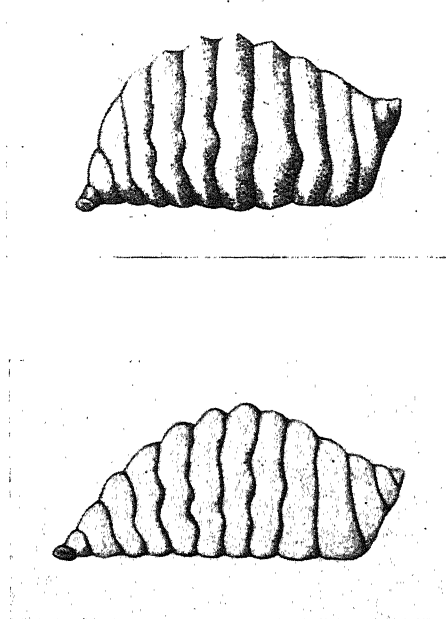


Fig. 2 — *Hibernant puparium (above) and non-hibernant puparium.*

<sup>3</sup> The author is indebted to Mr. Y. Nishijima for assistance in the ecological studies on the puparia.

## 2. Comparison of the dimensions of both types.

The hibernant puparia are usually short in length than the non-hibernant ones, while the width and height of the former are larger than those of the latter. The puparial skin of the hibernant types is much thicker than that of non-hibernant ones. The data obtained are given in Table 4.

Table 4. *Results of measurements*

Item	Type	No. of examined individuals	Mean	Maximum	Minimum	Standard deviation	Standard error
			mm	mm	mm	mm	mm
Length	Hibernant	30	2.598	2.81	2.19	0.163	$\pm 0.02103$
	Non-hibernant	30	2.855	3.25	2.43	0.215	$\pm 0.02774$
Width	Hibernant	30	1.645	1.92	1.26	0.144	$\pm 0.01858$
	Non-hibernant	30	1.595	1.81	1.41	0.099	$\pm 0.01277$
Height	Hibernant	30	1.542	1.81	1.12	0.131	$\pm 0.01819$
	Non-hibernant	30	1.385	1.58	1.19	0.102	$\pm 0.01316$
Thickness of puparial skin	Hibernant	20	0.0294	0.033	0.026	0.00199	$\pm 0.000314$
	Non-hibernant	20	0.0205	0.024	0.017	0.00207	$\pm 0.000329$

## 3. Difference of the ecological characters of both types.

*Hibernant puparium*

The puparium does not adhere closely to the rice-leaf, so that it easily fall off even a slight disturbance.

The puparium when transformed is light yellowish white, the colour soon changes to dark gray, and then it becomes nearly black.

The seasonal prevalences of the hibernant and non-hibernant puparia are clearly different every year. According to our investigations in 1945 at Nagayama, near Asahigawa, and Ono, near Hakodate, the appearance-rate of the hibernant puparia in the middle of July was about 2 %, increasing gradually, and was attained between 75 % and 97 % in the end of August, and the appearance-rate of the non-hibernant puparia was inversely proportional to that of the hibernant ones. On the contrary, the appearance-rate of the hibernant puparia in 1942 and 1944 was attained about 32 % in early July and 85 % or more in the end of the same month, and that in 1946 was attained about 25 % in early July or 68 % in the end of the same month, with an inverse proportion of the appearance-rate of the non-hibernant ones. The data mentioned above are detailed in Table 5.

Seeing in Table 5 it is noticeable that the appearance of the hibernant and non-hibernant puparia is apparently related to air temperature, though it may be controlled by many other environmental factors, and it is possible that the hibernant puparia increase with the rise of temperature and contrary the non-hibernant ones decrease. Although the experimental results have not yet been fully explained, it has a tendency to increase suddenly the appearance-rate of the hibernant puparia by the rise over 20° C of mean temperature. After his close examinations on the temperature-reaction

*Non-hibernant puparium*

The puparium adheres closely to the rice-leaf, and it does not easily fall off.

The puparium when transformed is light yellowish white, the colour changes to pale green, and then it becomes pale greenish brown or brown.

Table 5. *Appearance-rate of the hibernant puparia of the rice leaf-miner for observation, in 1942, 1944, 1945 and 1946, at Nagayama and Ono, Hokkaido.*

Month	Year	1942				1944				1945				1946	
		Ono		Nagayama		Ono		Nagayama		Ono		Nagayama		Nagayama	
		Per-centage	Tem-pera-ture	Per-centage	Tem-pera-ture	Per-centage	Tem-pera-ture	Per-centage	Tem-pera-ture	Per-centage	Tem-pera-ture	Per-centage	Tem-pera-ture	Per-centage	Tem-pera-ture
	Decade	(1)	(2)												
June	first	%	C°	%	C°	%	C°	%	C°	%	C°	%	C°	%	C°
	middle		15.6		15.7		14.7		15.6		11.1		12.8		16.9
	last		17.7		18.0		16.0		17.9		12.3		14.2		19.0
July	first	32.9	21.3		21.9		19.1	31.3	20.6		17.1		17.9	24.9	20.7
	middle		20.3		20.6	80.3	22.3		22.7	2.5	16.2	2.0	16.3	27.0	22.5
	last		22.2	84.6	21.4		22.7	87.5	22.9	3.0	16.6	2.6	21.3	68.2	21.6
Aug.	first		21.0		20.2		24.7		23.1	16.2	22.0	10.8	23.9		24.2
	middle		20.9		20.4		23.2		22.8	75.5	21.0	53.3	20.6		24.7
	last		20.8		19.1		22.2		21.6	90.4	23.8	69.9	22.2		23.0
Sept.	first		19.0		17.9		21.0		19.2	97.7 (3)	18.8	75.5	16.0		17.5

(1) Percentage means the percentage of the hibernant puparia to the total collected puparia in each time.

(2) Temperature means an average of daily mean temperature.

(3) Datum observed on August 31.

of the rice leaf-miner, Kato (3) reported that the ranges of temperature in the activity of larva are 12.9°—16.8° C on crawling, 17.2°—20.1° C on normal action, 26.4°—31.4° C on excitation, etc. These facts are suggestive to a future study on the mechanism of the appearance of the hibernant and non-hibernant puparia.

#### *Effect of Contact Poisons*

Three general measures have been recommended (2, 4, 13) and used for the control of the rice leaf-miner: Spraying with contact poisons, collection of the overwintered puparia before their emergence in spring, eradication of *Zizania latifolia* Turcz., a potential wild host. Of these measures spraying is most important, and numerous efforts were made by the author to determine by means of laboratory tests as well as field-control experiments the effects of contact poisons against the rice leaf-miner. The results of our experiments are summarized in the following tables.

According to the laboratory tests summarized in Table 6, pyrethrum insecticides are most effective, comparing with derris insecticides, and nicotine sulphate does not come up to these against adult flies; pyrethrum emulsion is somewhat superior on the effect against eggs, derris powder being rather inferior; and derris emulsion is conspicuously effective, following by derris powder, nicotine sulphate, and pyrethrum powder is least effective against larvae. The data obtained in the field experiments, as shown in Table 7, bring out the fact that derris emulsion is most effective to control the rice leaf-miner, followed by derris powder and nicotine sulphate, while pyrethrum insecticides are ineffective.

Table 6. *Summary of the experimental results in comparison of the effect of contact poisons against the adults, eggs, and larvae of the rice leaf-miner. Laboratory tests from 1941 to 1943, inclusive*

Material	Adults			Eggs		Larvae	
	Percent- age died	Percent- age killed	Average velocity to death	Percent- age hatched	Percent- age killed	Percent- age died	Percent- age killed
	%	%	hour	%	%	%	%
1. Derris powder	89.6	84.4	18.83	65.7	28.8	45.6	41.0
2. Derris emulsion	86.7	79.5	14.79	47.2	47.2	69.9	65.4
3. Pyrethrum powder	76.8	73.8	16.75	45.0	44.7	6.7	6.7
4. Pyrethrum emulsion	94.0	92.7	12.23	24.8	69.4	36.3	33.9
5. Nicotine sulphate	68.3	53.2	22.39	49.9	45.2	40.1	34.3
6. Water (check)	29.7	0	34.29	87.8	0	7.0	0
Number of experiments	4 (3 in lot no. 2 and 3)			4 (3 in lot no. 2, 4 and 5; 2 in lot no. 3)		5 (4 in lot no. 2, 4 and 5; 3 in lot no. 3)	

Formulas per 1 litre of water: derris powder (rotenone 5%) 1 gr., derris emulsion (rotenone 2%) 2.6 gr., pyrethrum powder (pyrethrine 0.8%) 4 gr., pyrethrum emulsion (pyrethrine 1.5%) 2.2 gr., nicotine sulphate (nicotine 40%) 1.25 gr., each adding 4 gr. of calcium arsenate and 2 gr. of soy bean flour (in 1941 and 1942) or 0.3 gr. of coconut oil sticker (in 1943).

Percentage killed and average velocity to death are computed from the data obtained, of which number of insects or eggs used in each lot were 10 to 30 individuals, by the following formulas:

$$\text{Percentage killed} = \frac{D}{m} \times 100$$

$$\text{Average velocity to death} = \frac{\sum a \times d}{Dn}$$

in which  $m$  number of individuals used,  $D$  number of the dead up to each observation time,  $Dn$  number of the dead at the final observation time,  $a$  lapsed hours,  $d$  number of the dead in each observation time.

#### *Rotenone Concentration in Derris Solution*

Since the results of indoor and field experiments revealed that derris has the effectiveness on the control of the rice leaf-miner, a comparative experiment on the concentration of derris emulsion in relation to the effect was attempted.



Table 7. *Summary of the results of field experiments under varying conditions in Hokkaido, in 1941, 1942, and 1943*

Treatment	No. of scratches by adults per 150 young riceplants	Percentage of do.	Percentages died of larvae						Average of percentage killed of larvae
			Ono 1941	Ono 1942	Nagayama 1942	Kotoni 1942	Nagayama 1943	Average	
1. Derris powder	68	11	39.2	46.2	40.8	2.0	67.9	39.2	34.3
2. Derris emulsion	—	—	—	56.5	64.2	18.2	78.7	54.4	51.6
3. Pyrethrum powder	152	24	35.9	30.4	—	—	—	33.0	26.1
4. Pyrethrum emulsion	138	22	26.3	52.9	25.3	—	49.1	38.4	31.7
5. Nicotine sulphate	458	72	59.3	37.5	51.9	2.6	37.7	37.8	32.5
6. Check	635	100	11.6	3.6	10.5	3.3	11.3	8.1	0

The formula of the solution of each poison is almost the same as in the laboratory tests. Date of spraying and that of examination are as follows:

Year	Locality	Date of spraying	Date of examination
1941	Ono	June 1, June 8, July 1, July 11	July 14
1942	"	June 1, June 10, July 3, July 11	July 13
	" Nagayama	July 26	July 31
	" Kotoni	September 12	September 15
1943	Nagayama	June 11, June 25, July 15	July 20

Number of the scratches by adult flies per 150 young rice-plants were examined at Ono on June 13, 1941.

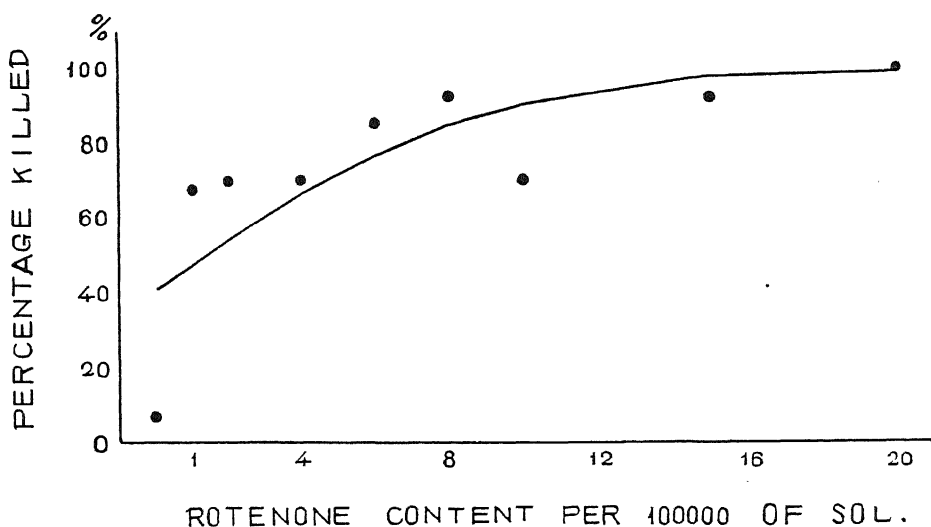


Fig. 3 — Concentration of derris emulsion versus percentage killed of the rice leaf-miner.

Table 8. Results of experiment on the effect against the rice leaf-miner versus the concentration of derris emulsion. Laboratory test at Kotoni, near Sapporo, in 1942 and 1943

Material	Concentration of rotenone	Percentage died of larvae on 120 hours after treatment	Provisional Percentage died of ditto	Percentage of emergence from hibernant puparia	Total percentage died	Percentage killed
		%	%	%	%	%
Liquid 1000 cc: Derris emulsion 10 gr.	20/100000	37.5	56.3	0	100.0	100.0
Do. : " " 7.5 gr.	15/100000	13.3	46.7	0	93.3	92.3
Do. : " " 5 gr.	10/100000	6.7	6.7	9.1	73.3	69.1
Do. : " " 4 gr.	8/100000	25.0	25.0	8.2	93.8	92.8
Do. : " " 3 gr.	6/100000	6.7	6.7	14.3	86.7	84.7
Do. : " " 2 gr.	4/100000	6.7	6.7	28.6	73.3	69.1
Do. : " " 1 gr.	2/100000	12.5	12.5	33.3	73.3	69.1
Do. : " " 0.5 gr.	1/100000	0	0	35.7	71.4	67.0
Do. : " " 0 gr.	—	6.7	6.7	85.7	20.0	7.7
Water (check)	—	0	0	85.7	13.3	0

Experiment was opened by spraying on September 14, 1942, and finished by the examination of hibernant puparia in June, 1943.

Liquid is the solution of calcium arsenate (4 gr. of calcium arsenate and 2 gr. of soy bean flour per 1 litre of water).

Provisional percentage died of larvae is calculated the dead and coma together.

It will be noted that though the larvae sprayed with derris emulsion escape death and pupate the emergence from those puparia is very few. The data indicate also that the percentage of emergence decrease in proportion to the increase of used quantity of derris emulsion, and taking into consideration the percentage died of larvae, 1 % solution of derris emulsion bears complete effect by the killing *in toto*, but the use of 0.25 % or more concentrated solution of the same indicates more than 80 % in the percentage killed. From these results it may be recommended that the concentration of derris solution for the rice leaf-miner in the practical usage is about 0.25 % of derris emulsion.

### Summary

The rice leaf-miner, *Agromyza oryzae* M u n a k a t a, is one of the most important rice pests in the northern part of Japan.

Life history studies of this species indicate that annually there are one to three generations in Hokkaido. The adult flies begin to emerge in the end of May or early June from the hibernated puparia. The last appear as late as the end of June. The second-brood adults appear from late June to early July or later, and the third-brood adults appear in early August.

It will be noted that there are two different types of the puparia, hibernant and non-hibernant, in each generation. Two types of the puparia may be distinguishable morphologically in colour, shape, and size, and also ecologically in the condition of adhesion to the rice-leaf, colour change after pupation, etc. The hibernant puparia increase with the transition of season, the appearance-rate of the non-hibernant puparia being inversely proportional to that of the hibernant ones. The seasonal prevalence of these two types of puparia, however, are considerably different every year, apparently due to the air temperature and other climatic conditions. It has a tendency to increase suddenly the appearance-rate of the hibernant puparia by the rise over 20° C of mean temperature.

Of the recommended control measures spraying is most important at present. The results of the laboratory tests and field experiments are concluded that derris emulsion, following by derris powder, is most effective and stable insecticide against the rice leaf-miner rather than nicotine sulphate or pyrethrum. One per cent solution of derris emulsion bears complete effect by 100 per cent killing of the larvae, but 0.25 per cent solution may be a practical concentration limit by about 80 per cent killing.

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<sup>4</sup> All are written in Japanese, excluding Hendel's paper.

## LES RECHERCHES FRANÇAISES SUR LE HANNETON COMMUN

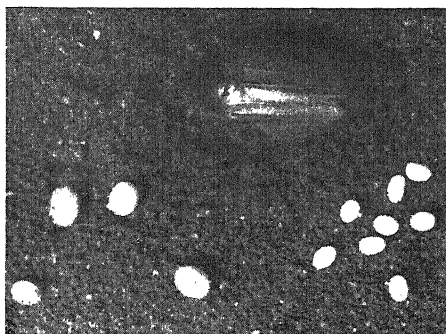
### *Melolontha melolontha* L

Par Robert Régnier

Le Hanneton commun (*M. melolontha* L.) est classé en Europe depuis un temps immémorial parmi les grands ennemis des cultures : l'insecte parfait se nourrit du feuillage de nombreux arbres fruitiers et forestiers : la larve ou ver blanc s'attaque aux racines d'un grand nombre de végétaux : les cultures potagères, le fraisier, la betterave, la pomme de terre, les céréales, les graminées fourragères et les plants de pépinières sont les plus éprouvés. Depuis une douzaine d'années, mais surtout depuis 1940/41, on enregistre une recrudescence marquée des dégâts, à laquelle l'état d'abandon de nombreuses terres dû à la situation de guerre n'est certainement pas étranger; en outre la concordance des années de sécheresse avec celles de grande activité des vers blancs (larves de seconde année) a provoqué une aggravation des dommages dont la production s'est vivement ressentie.

Dans certaines régions, les agriculteurs ont de ce fait envisagé de renoncer à certaines cultures, telles que la betterave, l'une des plantes les plus sensibles, si l'on ne trouvait pas une solution au problème. L'enjeu est d'importance, puisqu'il peut avoir pour conséquence la marche au ralenti et peut-être même la fermeture de quelques usines, ainsi que la diminution de la production sucrière. Il est certain que lorsqu'on voit, comme nous l'avons constaté dans le Beauvaisis, le rendement tombe deux années sur trois à moins de 10 tonnes de betteraves à l'hectare, on est en droit de se demander si l'on doit persévérer. Les dégâts dans les prairies du pays de Bray (Normandie) et des Vosges ne sont pas moins spectaculaires et n'ont pas été sans influence sur la production laitière. Les pépiniéristes perdent les années à vers blancs des milliers de plants. Les fraisiéristes sont également très touchés. Il n'est pas exagéré de dire que les hannetons coûtent au pays des milliards de francs. D'après les informations que nous avons reçues des États limitrophes, la situation devient également angoissante en Suisse, en Belgique et même en Italie.

C'est pour répondre à ces préoccupations que le Ministère de l'Agriculture a chargé en 1938 la Station de Zoologie Agricole du Nord-Ouest que je dirige de reprendre par la base la question du Hanneton en liaison avec les milieux intéressés. D'importantes recherches ont donc été engagées, que la guerre a momentanément interrompues en raison de notre position dans une zone d'opérations militaires, mais elles ont pu être intensifiées dès 1946 grâce au concours des groupements locaux de défense contre les ennemis des cultures (Seine-Inférieure et Oise) et surtout grâce au concours financier de l'Institut technique de la Betterave, plus spécialement intéressé. Deux laboratoires de campagne ont été créés, l'un au nord de Rouen, à Saint-Saëns (Seine-Inférieure) dans la zone soumise au régime II, l'autre dans l'Oise à la Neuville-en-Hez à la lisière de la forêt de Hez en zone soumise au régime I. Des résultats importants ont été acquis tant au point de vue biologique qu'au point de vue pratique, à la suite d'expériences faites sur les insectes et sur les larves, et permettent d'entrevoir une solution du problème.



1

2

1 Les oeufs aussitôt la ponte,  
2 Les oeufs avant l'éclosion.

#### Recherches biologiques.

L'enquête nationale commencée en 1939<sup>1</sup> a permis de préciser d'une part la situation des différents régimes, et d'autre part les zones de grands dégâts.

En France il n'existe en fait que trois régimes, le cycle se faisant normalement en trois ans, les deux ou trois points où l'on a observé un cycle de quatre ans n'ayant pas de valeur pratique. Le *M. melolontha* apparaît d'autre part la seule espèce vraiment dangereuse, les vols de *M. hippocastani* sont très localisés. Nous en avons enregistré cette année un vol réduit dans l'Oise autour de notre laboratoire de campagne; les insectes sont sortis plus tardivement (fin mai au lieu de fin avril pour *M. melolontha*) et en petit nombre: 4 à 5 pour 100 par rapport aux Hanneçons communs auxquels ils étaient mêlés.

Ainsi que nous l'avons exposé à l'Académie d'Agriculture<sup>2</sup> la définition des régimes peut être simplifiée par un procédé très simple qui consiste à diviser la somme des chiffres du millésime de l'année de vol par 3: suivant que le reste est de 1, ou 2 ou que la somme est exactement divisible par 3, on dit que la région envisagée est soumise au régime I, II ou III — Exemple: vol en

$$1945 : 1+9+4+5 = 19 : 3 = \text{Reste } 1 = \text{Régime } I$$

$$1946 : 1+9+4+6 = 20 : 3 = \text{Reste } 2 = \text{Régime } II$$

$$1947 : 1+9+4+7 = 21 : 3 = \text{Reste } 0 = \text{Régime } III$$

On évite ainsi les erreurs de calcul dues à la terminologie suisse: les mots bernois, uranien, bâlois sont sans signification pour les autres pays, et n'ont d'ailleurs rien d'absolu.

Il est à noter qu'aussi loin que nous avons pu remonter pour certaines régions déterminées le régime reste constant; en Normandie par exemple, on a enregistré de grands vols de hanneçons en 1832, 1865, 1892, 1901, 1910, 1919, 1934: on remarquera que la somme de ces millésimes divisée par 3 laisse toujours un reste de 2, donc la région demeure soumise au régime II, les petits vols observés d'autres années n'ayant pas été importants.

Il est d'autre part un axiome qui ne doit jamais être oublié : ce sont les arbres qui nourrissent le Hanneçon, et les cultures sa larve. C'est toujours à proximité des massifs boisés que les dégâts sont les plus graves, le terme "massifs boisés" n'implique pas obligatoirement la présence de forêts ou même de grands bois; les régions de bocages sont également souvent très éprouvées, de même que les zones betteravières émaillées de boqueteaux telles que le Beauvaisis, où les hannetons viennent se grouper plutôt que sur la lisière des forêts. Il y a là un phénomène de convergence, dont il convient de tenir compte, lorsqu'on établit la carte de prévision des vols, qui conditionne l'organisation de la lutte : il semble en effet que le Hanneçon commun ait une sorte d'instinct grégaire assez développé qui stimule son appétit; il est stupéfiant de voir avec quelle rapidité — souvent moins de 48 heures — les grands chênes sont entièrement dépouillés de leurs feuilles par les bandes de hannetons alors que les insectes isolés ou en cages ne consomment qu'une quantité réduite de feuillage. Notre laboratoire poursuit actuellement à ce sujet des recherches qui peuvent ne pas être sans incidence sur les méthodes de lutte : il est possible qu'en traitant les seuls boqueteaux où ils se rassemblent, on arrive à réduire considérablement les dégâts. L'aménagement forestier des régions à grands dégâts est d'autre part un point qui a retenu depuis longtemps notre attention, le fait que les vols n'intéressent jamais que les lisières forestières de feuillus et quelquefois de mélèzes doit nous inciter à porter principalement notre attention sur les bois isolés, et à adopter des mesures appropriées.

Les recherches biologiques ont porté sur le déclenchement des vols, l'alimentation et les déplacements des insectes, le déterminisme de la ponte et le développement des oeufs, sur l'évolution et l'activité des larves en fonction des cultures, ainsi que sur la nymphose. Parallèlement des études de laboratoire sont poursuivies sur l'anatomie et la physiologie de l'insecte et du ver blanc ainsi que sur le parasitisme.

Dans la moitié nord de la France, les grands vols ne commencent pas avant le 20 avril, et pratiquement il n'y a plus de hannetons après le 10 juillet. Les vols ont débuté en 1948 en zone I (Oise) le 22 avril à 20h. 15 (température 11°, luminosité 50 lux) et ont atteint leur maximum les 27 (10°) et 28 avril (14°). La pluie et le froid qui ont sévi les 29 et 30 avril ont amené beaucoup de hannetons à s'enterrer, l'activité est redevenue intense les 5 et 6 mai et a diminué à partir du 7 mai. Les grandes sorties ont coïncidé, comme dans les cas observés précédemment avec le débourrement du hêtre et du chêne, qui restent les essences les plus attaquées.

Les vols ne durent pas plus de 25 à 30 minutes et le bourdonnement intense qui les accompagne cesse en général au bout d'une heure. La consommation de feuillage, relativement réduite pour les individus isolés ou captifs croît en raison directe de leur densité : cet accroissement semble résulter d'une excitation collective. Au début les mâles sont nettement plus nombreux que les femelles, au bout de trois semaines environ leur nombre est égal, puis celui des mâles diminue rapidement.

La ponte commence au plus tôt 18 à 20 jours après les vols et se prolonge jusqu'en juin, elle est d'une vingtaine d'oeufs en moyenne, et atteint rarement 40. Nous n'avons jamais observé des pontes multiples, mais constaté la tendance fréquente des insectes à s'enterrer. L'oeuf augmente de volume, celui-ci passe du simple au triple au moment de l'éclosion des jeunes larves.

L'éclosion a lieu en juillet et de nombreux vers blancs atteignent leur deuxième âge (poids 0 gr 35 à 0 gr 50) avant l'hiver. Leur densité peut être considérable; nous en avons compté en première année jusqu'à 1175 au mètre carré. Ce nombre est tombé

à 300 au printemps suivant (larves de deuxième âge) à 70 au cours de l'été (larves de troisième âge) et à moins de 30 en troisième année.

Les vers blancs redoutent la sécheresse — aussi les a-t-on vus descendre profondément pendant l'été très chaud de 1947 — et fuient la trop grande humidité; les prairies sujettes aux inondations sont généralement les moins attaquées.

Dans nos régions de grande culture, les dégâts de vers blancs cessent pratiquement avant la fin de juin de la troisième année, la nymphose qui se fait entre 20 et 30 cm a lieu en juillet, et les hannetons sont formés fin août.



*Dégâts de vers blancs de deuxième  
année sur Pommes de terre.*

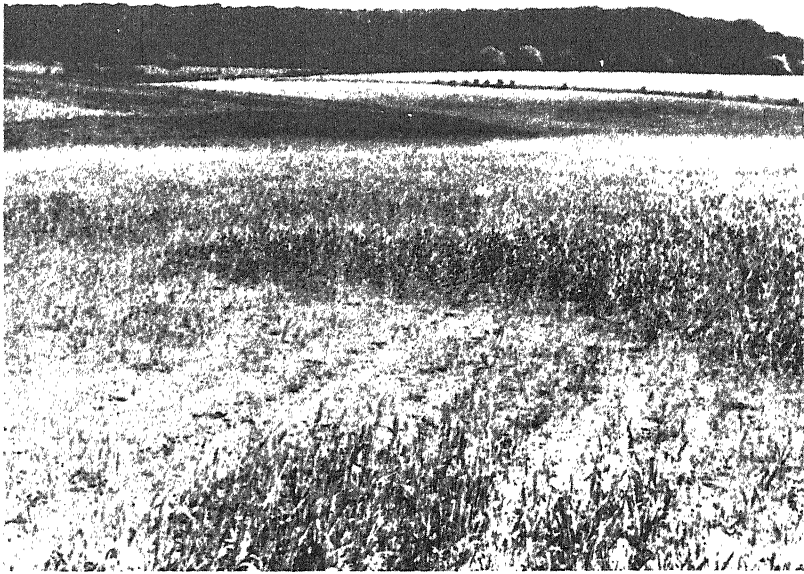
#### *Recherches expérimentales.*

La partie expérimentale a été développée suivant un programme méthodique et en tenant compte des exigences culturales et des conditions économiques d'application, variables suivant la nature des cultures.

De nombreux essais ont été effectués tant pour déterminer la portée des façons culturales et de l'emploi des engrais, que pour apprécier la valeur des méthodes chimiques de lutte sur les insectes et sur les larves, notamment avec les nouveaux produits organiques de synthèse.

Au mois de mai dernier a été réalisé dans le Beauvaisis un essai de poudrage par avion d'un bois envahi par les hannetons avec le H.C.H. (Hexa-Chloro-Cyclohexane).

Actuellement est en préparation en zone I une grande expérience combinée contre les larves de première année dans les cultures de betterave du secteur de Bresles (Oise) sur une étendue d'environ deux mille hectares. Conjointement seront utilisés à des dates différentes des méthodes de travail du sol (déchaumage, disquage, scarifiage) d'épandage de cyanamide et de produits organiques de synthèse (HCH et SPC) ainsi que des mélanges d'engrais et d'insecticides. L'examen des rendements comptabilisés par la Sucrerie de Bresles permettra d'apprécier d'une manière précise les résultats obtenus, et de généraliser l'année suivante l'application des procédés efficaces en zone II, où il faut s'attendre à des dégâts considérables.



*Dégâts de Vers blancs (deuxième année) sur Avoine. La Feuillie (S. I.) 1938.*

#### *Résultats pratiques.*

L'étude des moyens de lutte nous a amené à déconseiller le ramassage des insectes et des larves, qui dans les conditions actuelles est une opération onéreuse et par surcroît d'une efficacité réduite. Par contre, les façons culturales appliquées au moment opportun, c'est-à-dire quand les larves sont dans la couche superficielle du sol, ont une action certaine sur les larves de deuxième et de troisième âges, du fait de la sensibilité des vers blancs aux chocs et aux frictions, et à la condition que l'on utilise des machines (pulvérisateurs, motoculteurs à fraise) à effets multiples et à traction rapide : suivant le mode de locomotion, les résultats sont du simple au triple. La grande expérience prévue cette année au moment du déchaumage permettra d'être prochainement fixé sur la valeur de la méthode vis à vis des larves de premier âge.

L'action de la cianamide est discutée; en combinant son emploi à certaines façons culturales, nous espérons arriver à un résultat en grande culture. Près de 500 tonnes vont être utilisées à cet effet dans notre grand essai en zone betteravière.

Les hannetons sont sensibles aux produits organiques de synthèse, tels que le D.D.T., le H.C.H. (Gammexane) le S.P.C. (sulfure de polychloro cyclane) qui sont d'un emploi facile en poudrage et permettent de protéger efficacement les arbres fruitiers et les plants de pépinières. Les essais de poudrage par avion avec HCH ont permis de détruire environ 40 à 50 % des hannetons dans le bois traité, mais il semble possible d'élever le pourcentage en utilisant soit un hélicoptère ou un avion à marche moins rapide (60 à 70 Km heure au lieu de 120) une poudre à teneur en HCH moins forte (5 à 8 % au lieu de 25 %) et une quantité plus élevée de poudre (30 à 40 Kgs au lieu de 15 à 20 à l'hectare). La capacité de charge de l'appareil est également à considérer, ainsi que

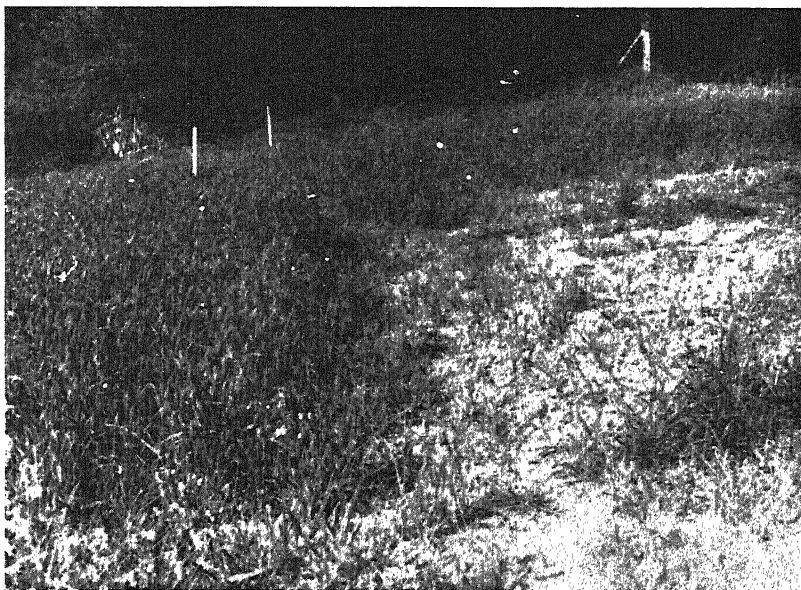


l'action sur les insectes utiles notamment les abeilles. De nouveaux essais sont nécessaires et seront effectués au printemps 1949 en zone II.

L'effet du HCH et du SPC sur les larves est indéniable, mais la généralisation de leur emploi pose des problèmes qui ne sont pas entièrement résolus. Non seulement leur utilisation en grande culture soulève des objections économiques, en raison de leur prix de revient, mais leur incorporation dans le sol peut ne pas être sans inconvénient, tant à cause de l'odeur communiquée aux tubercules et à certaines racines qu'en raison de la rémanence du produit qui peut agir défavorablement sur la végétation; il semble qu'on ait avantage à s'orienter vers des concentrations réduites (10 à 15 % de produit technique à l'Ha) les accidents végétatifs se produisant à partir de 25 Kgs de HCH pour la betterave et l'avoine, et à incorporer le produit dans le sol assez longtemps avant la mise en culture, aussitôt le déchaumage, ou dans le cours de l'hiver pour les semis de printemps.

Dans les cultures potagères, le produit qui jusqu'à de jour nous a donné les meilleurs résultats est le SNP, du groupe des esters phosphoriques mixtes (Thiophosphate de Diethyl et de Paranitrophényl = E 605) enfoui par bêchage ou ratissage à la dose de 2 Kgs de produit à 0,5 % à l'are.

Les recherches sont actuellement orientées vers l'emploi des engrais insecticides : nous n'en avons pas encore l'expérience, mais nous avons constaté dans un grand essai en prairie puis dans une culture d'orge les bons résultats obtenus avec les mélanges chlorure de potassium-HCH ou -SPC, et nous pensons que ces mélanges ont un certain avenir.



*La partie  
détruite n'a  
pas été  
traitée.*

*Essai sur orge. Action du Sulfure de Polychlorocyclane (S.P.C.)  
sur les larves de deuxième année. Saint-Saens 1947.*

*Conclusion.* Je n'ai pas besoin de souligner l'importance de ces recherches auxquelles participent sous ma direction toute une équipe d'ingénieurs et d'agents techniques ainsi que de nombreux agriculteurs à qui je tiens à rendre hommage.

Le problème des hannetons présente en raison de la diversité des cultures attaquées tant d'aspects différents qu'il est difficile de généraliser sans contrôle les méthodes de lutte préconisées, mais il est permis d'affirmer que les recherches sont arrivées à un stade qui permet d'en entrevoir la solution. Comme le disait notre éminent maître le Professeur Marchal "Pour atteindre les grands ravageurs il faut mettre en oeuvre tous les moyens dont on dispose et en combiner l'application". Les progrès chimiques nous apportent un immense espoir, mais ils ne doivent pas nous faire oublier la valeur des méthodes culturales et dans une certaine mesure l'intervention efficace des prédateurs et peut-être dans un proche avenir des parasites. En raison de l'importance qu'ont ces recherches pour le continent européen, nous renouvelons le vœu exprimé à la conférence de la Betterave à Bruxelles pour que tous les Etats intéressés par la question conjugent leurs efforts et coordonnent leurs travaux.

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<sup>1</sup> R. Régnier — Résultats de l'enquête et des récentes recherches sur les Hannetons *C. R. Acad. Agr. mars 1941*.

<sup>2</sup> R. Régnier — Les recherches sur les Hannetons. Doit-on continuer à préconiser le hannetonnage. *C. R. Acad. Agr. Décembre 1946*.

THE INFESTATION OF YOUNG CABBAGE PLANTS BY CEUTOR-  
RHYNCHUS RAPAE Gyll. (Col. Curculionidae) AT  
DEDEMSVAART (PROV. OVERIJSEL, HOLLAND)

By *G. van Rossem*

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I. INTRODUCTION

Since 1929 it has been observed that young cabbage plants in the neighbourhood of Dedemsvaart have been infested with weevil larvae from April till July. Serious losses to cabbage crops have taken place especially during the last 6 years. Growers can no longer raise young plants for their own use because of this infestation of their seeds beds; they have been compelled to obtain young plants from other localities. A serious decline in cauliflower cultivation in the Dedemsvaart region has been the result.

At first the larvae were identified by Bernet Kempers (c. f. Schoevers 1941) as belonging to the genus *Baris*. This identification has been disproved by my researches and observations during 1946 and 1947 from which it is now clear that most of the damage is caused by *Ceutorrhynchus rapae* Gyll.

An interesting point in the observations on this weevil is the strict local character of the infestation. Up till now damage from *C. rapae* larvae has not been found in the main Dutch cabbage growing districts. Apart from the area of infestation at Dedemsvaart slight damage is reported from the north-eastern provinces of Drenthe and Groningen. In these districts cabbage cultivation is not of such great importance as elsewhere in the Netherlands.

The observations recorded here are the results of laboratory and field work, the former carried on at the Phytopathological Service laboratory, Wageningen, and the latter on vegetable nurseries at Dedemsvaart. Our observations on the biology, the economic importance and the possibilities of control of *C. rapae* will be dealt with in this paper.

*Methods.*

The main purposes of my investigations were to ascertain:

- a) the species causing the damage;
- b) the life history;
- c) the possibilities of control.

The investigations on the last mentioned point are not yet completed, although there are indications that successful means of control will be found.

After a failure in 1946 (van Rossem 1948 a) to rear the larvae, owing to the difficulty of keeping the larvae under observation while developing, I was more successful in 1947 (van Rossem 1947). The working method was then changed and the adults were obtained without further difficulties. For this purpose plants harbouring nearly full grown larvae were gathered in the field. These plants were laid out in glass-dishes. Within a short time the larvae left the foodplants and were transferred to glass-tubes, half filled with soil. The adults were then easily obtained.

Galled plants were kept in cages exposed to natural conditions. In these cages the imago was also obtained but it was rather difficult to find the weevils as these insects have the habit of dropping to the soil, when disturbed. They hide between soil particles and are often lost.

Particulars as to development were obtained from galled plants in pots, which were kept in the laboratory. In general it is not possible to pull up infested plants from the seedbeds and transfer these to pots. Even the young larvae leave these plants and die. Therefore we placed the pots in the seedbeds before sowing. The plants will develop normally and after infestation has taken place, the pots can be taken from the seedbeds without damaging the plants.

## II. THE ADULT

Adults of *Ceutorrhynchus rapae* Gyllenhal, 1837, closely resemble those of *C. napi* Gyllenhal, 1837. Through the kindness of Dr René Malaise of the Naturhistoriska Riksmuseum at Stockholm the author had the opportunity to study the holotypes of both species. The holotype of *Ceutorrhynchus rapae* Gyll. is a male in the Stockholm Museum, it agrees with the modern interpretation of the species. *C. rapae* is further represented by two paratypes.

According to authors *C. napi* may be distinguished from *C. rapae* by the presence of a small dorsal tubercle on both sides of the pronotum of *C. rapae*. The teeth are absent on the pronotum of *C. napi*. This character however is rather indistinct. There is a distinct difference between *C. rapae* and *C. napi* in the sculpture of the dorsal surface of the pronotum.

*C. rapae*: surface of pronotum with round, deep punctures, which are scarcely separated. Margins of punctures smooth, giving a shining appearance to the dorsal surface of the pronotum. Hairs short and indistinct.

*C. napi*: surface of pronotum with shallow, more or less hexagonal punctures, separated only by their sharp margins. The appearance of the dorsal surface of the pronotum is not shining. The inside of the punctures is more or less obtuse, conically elevated, giving rise to a distinct scalelike, grey hair.

*Distribution.*

*C. rapae* is a palaearctic species (c.f. Dalla Torre et A. Hustache 1930). It was introduced in the New World about 1855 (Blatchley 1916) and has since then been

found locally abundant near New York City on cruciferous plants. The species ranges from Canada and New England to California, mainly in the Upper Austral life zone. (Blatchley l.c.)

There is a paper by Chittenden (1900) on the economic importance of the species in the U.S.A.

*Distribution in the Netherlands.*

*C. rapae* has been found in the following localities. The numbers in brackets giving the month of collecting. Assen (VI) (Everts 1907); Vorden (VI); Dedemsvaart (IV, V, VI, VII); Arnhem (no date); Groesbeek (V); de Bilt (VI); Westerschouwen (no date). From the faunistic point of view *C. rapae* is a rare species.

*Other Ceutorrhynchus species.*

In the Dedemsvaart area *C. quadridens* Panz. was also found infesting young cabbage plants. The damage from this species may be recognized with some difficulty from that of *C. rapae* (see page 000). The larvae of *C. quadridens* are found in the stems and leafstalks of the plants. In general there are several larvae living together in one plant (van Rossem 1948 b).

Günthart (1947) reports *C. napi* to be injurious to young rapeseed (*Brassica napus* L.) plants in Switzerland. From his description it seems that the infestation of this species is very much like that of *C. rapae*. *C. napi* has been found in Holland in young, hibernated crops of rapeseed and swede-seed (*Brassica rapa* L. var.), however no damage was reported. *C. napi* has up till now never been found in cabbage crops.

### III. BIOLOGY

*Oviposition and the egg.*

The time of emergence of the hibernated adults depends much on climatic conditions in spring. After the severe winter of 1946—1947 the emergence took place in the second half of April which is closely in accordance with the time of emergence of other *Ceutorrhynchus* species in the Netherlands (e.g. *C. quadridens* first observation on 12.IV.'47; *C. contractus* Marsh. first obs. 12.IV.'47). Although the winter of 1947—1948 was in general very mild, a sudden cold spell of weather kept the weevils back until the 20th of April. On that date the author observed many specimens of *C. rapae*, crawling on the sandy soil of cauliflower seedbeds. The plants by that time were not yet far enough developed for oviposition.

Depending on weather conditions and the development of the plants another fortnight passes before the first eggs are laid. In 1947 the earliest oviposition was found between the 10th and 14th of May; in 1948 this date was the 26th of April.

It has been possible to observe full details of the oviposition in glass-jars in which cauliflower seedlings were planted. In each jar a male and female could be placed without difficulties as the weevils were copulating in the collecting tubes. Copulation was also observed in the field. From this it seems clear that the copulation takes place in spring, shortly before oviposition. The fertilized female crawls up the stem and chooses the spot for oviposition. This is found in the stem just underneath the growing-point. The weevil starts to drill a hole with the rostrum. During the act of drilling the position of the weevil on the stem is tail upwards, head downwards. The rostrum gradually disappears into the stem. In two observations we noted that the drilling took 12 to 15 minutes. The insect then turns the head upwards after which the egg is

thrust into the wound by means of the ovipositor. The laying of the egg took 3—6 minutes. Most probably the wound is closed with a hardening secretion. This protective covering was found by me while opening infested plants. It was noted by Isaac (1923) in his study of *C. pleurostigma* Marsh. Also Kuenen (1947) mentions the protective covering in his observations on the biology of *Anthonomus cinctus* Redtb.

Newly infested plants are easily recognized by means of the oviposition puncture. The surface tissue of the plant becomes slightly sunken around the puncture.

In general the female lays only one egg per plant, at any rate many plants are found with only one larva. In case there are more larvae per plant, there is the possibility of different females ovipositing in the same plant. In the glass jars several eggs were laid by one female in the same plant during a couple of weeks, but this can not be compared with the natural conditions. From our observations in the laboratory it became clear that the period during which oviposition takes place lasts at least 2 months. In the field eggs may be found from the beginning of May until the end of July. One fertilized female is able to infest a great many plants.

Körting (1942) described the oviposition of *C. quadridens* and he ascertained that this species deposits a maximum of 10 eggs in one clutch. From 86 clutches he calculated an average of 3.7 eggs in a clutch. This shows a striking biological difference between *C. rapae* and *C. quadridens*, which may be of practical importance for the recognition of the infestation of the species in the field.

During the embryonic development the egg becomes firmly enclosed in the plant tissue. This is first of all the result of a certain stimulus which may be imparted both by the activities of the female and the presence of the egg. The malformation of the plant tissue seems to cause pressure on the egg, so that this may show some

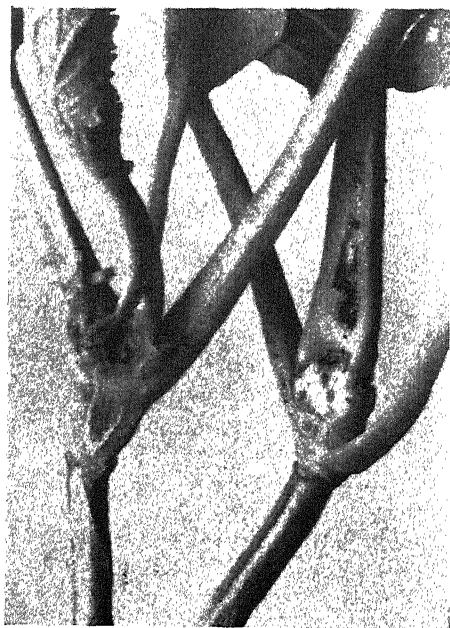


Fig. 1.



Fig. 2.

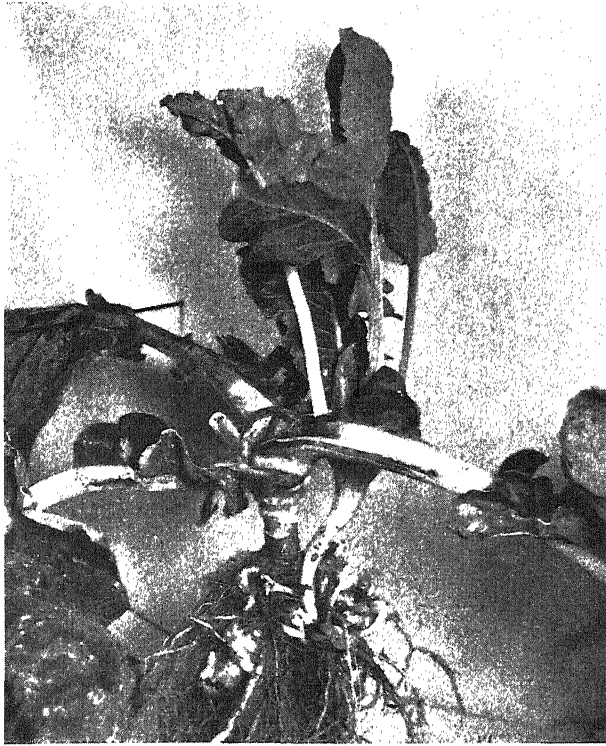


Fig. 3.

difference in shape. A series of 5 developing eggs were measured and gave the following dimensions:  $0.40 \times 0.31$  mm;  $0.62 \times 0.37$  mm;  $0.68 \times 0.37$  mm;  $0.75 \times 0.50$  mm;  $0.75 \times 0.56$  mm. The last mentioned egg contained a complete larva, ready to hatch. The embryonic development takes 5 to 8 days.

After the hatching of the larva the growth of the gall continues, so that a typical malformation of the plant is caused (fig. 1). This malformation consists of a swelling in the immediate vicinity of the growing point. Thus the damage could be mistaken for that of *Contarinia nasturtii* Kieff. (*C. torquens* de Mey.)

#### *Larval instars.*

The young larva eats its way through the parenchym, forming a cavity just under the growing point. As a result of this the main sprout dies off in many cases, so that the plant is worthless to the grower. If the further development of such plants is followed, the formation of many secondary sprouts may be observed (see fig. 2 and 3).

There are 3 larval instars in *Ceutorrhynchus rapae*. It seems probable that this number occurs throughout the genus *Ceutorrhynchus*. Isaac l.c. found it for *C. pleurostigma* and Körting l.c. for *C. quadridens*.

The average dimensions of the 3 instars of *C. rapae* are the following:

1st inst.	total length larva	0.75—2 mm;	width head-capsule	0.30—0.44
2nd „	„ „ „	3—5 „ „	„ „	0.52—0.66
3rd „	„ „ „	6—7 „ „	„ „	0.70—0.85

The duration of each larval stage has not been studied, but the complete development of the larva occupies about 2 to 3 weeks.

#### *Pupation.*

As soon as the larvae are full fed they leave the plant and drop to the soil. Pupation takes place in the upper layer of the soil (ca 3 cm). The cocoon has not been studied yet, but most probably it does not differ much from that of *C. pleurostigma* (c. f. Isaac l.c.), *C. quadridens* (c. f. Körting l.c.) and further that of *C. napi*, the cocoon of which species I have seen through the kindness of Günthart in Switzerland. The cocoon of these *Ceutorrhynchus* species consists of soil particles stuck together by means of a secretion. In the laboratory the pupal period took from 13 to 21 days. The whole period of development from egg to adult takes 3 to 5 weeks.

#### *Seasonal appearance.*

There is one brood in the year of *C. rapae*. The young beetles emerge during July and August. In general they are harmless to the cabbage crop, but in 1941 a case of severe damage caused by the fresh weevils was reported by Schoevers (1942). Although we have not been able to follow the activities of the young weevils in the field, it may be expected that they soon hide in suitable places and become latent until the next spring.

With regard to the feeding of the hibernated weevils we observed bad damage to the plants in the glass jars in the laboratory. The many feeding punctures on the stem causing distortion and gall-like cell formation. This damage has up till now not been seen in the field, although now and then feeding punctures may be found in the seed-beds.

#### *Host plants.*

The author observed different varieties of *Brassica oleracea* L., such as white cabbage, cauliflower and brussels-sprouts as the hostplant of *C. rapae*. Red cabbage is less liable to be attacked, nevertheless this variety was found infested in some cases.

### IV. POSSIBILITIES OF CONTROL

Since the serious increase of the infestation in the Dedemsvaart area several field experiments for the control were carried out. However no results were obtained until 1948.

Credit has to be given here to the Swiss worker Günthart for his first successful experiments with hexachlorocyclohexane (HCH = 666) in the control of *Ceutorrhynchus napi*, which is a serious pest of rapeseed (*Brassica napus* L.) in Switzerland. Our experiments in 1947 with modern insecticides failed owing to a low percentage of infested plants in the experimental plots. In 1948 new experiments were carried out under the supervision of the horticultural section of the Phytopathological Service. Through their kindness I have the opportunity to give a summary of the provisional results of this years' experiments.

Soil treatment with Agrocide II (666) at the rate of 3/4 kg per 30 m<sup>2</sup> applied in the early spring before the sowing gave no results. Further experiments were carried



out with hexachlorocyclohexane (dust) at the rate of 40 kg/ha; hexachlorocyclohexane used as a wettable powder (1 %) at the rate of 10 liters/100 m<sup>2</sup>; DDT-emulsion (0.4 %) a.t.r.o. 10 l/100 m<sup>2</sup>; E 605 (paranitrophenyl-di-aethyl-thiophosphate) (0.04 %) a.t.r.o. 10 l/100 m<sup>2</sup>.

The first treatment with these chemicals was applied during the period in which the weevils were emerging (second half of April). A second treatment with the same chemicals was carried out on the 19th of May. From a provisional judgement of the information obtained it is obvious that the percentage of infested plants is decreased by the treatment with hexachlorocyclohexane (dust), DDT-emulsion and E 605. There appears also a tendency for the larvae to be killed within the plant, apart from the destruction of the adults on the plants.

No results were obtained from the hexachlorocyclohexane wettable powder treatment. This does not agree with Günthart's (1946 and 1947) experiences with *C. napi*. Information is however still insufficient so that the experiments will have to be carried on next year.

Growers obtained some results with the following practical method. Abnormal thick sowing causes a poor condition of the seedlings. The stems become thin and hard. These plants seem to be less liable to infestation, so that a certain decrease of the damage is obtained.

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## EIN NEUER SCHÄDLING IN EUROPA (HYPHANTRIA CUNEA Drury)

Von *Paul Surányi*

Die Zahl der eingeschleppten Schädlinge in Europa hat sich wieder um einer neuen Art vermehrt. Es wurde nämlich der in Nordamerika sehr bekannte „fall webworm“ (*Hyphantria cunea* Drury) kurz vor dem zweitem Weltkriege auf unbekannte Weise nach Ungarn eingeschleppt. Das war der erste Fall, dass dieser Schädling ausserhalb von Amerika beobachtet wurde.

Die ersten zwei Exemplare von Schmetterlingen hat im Mai 1940 ein Lepidopteren-sammler im Dorfe Csepel bei Budapest gefangen. Der Schädling blieb aber bis 1945 verborgen. Erst in diesem Jahre lernten wir die Raupen und die charakteristischen Raupennester kennen. Es gelang uns im Herbst 1946 diesen neuen Schädling zu bestimmen, als wir bereits die ersten Schäden beobachten konnten.

Der Schmetterling (*Hyphantria cunea* Drury) gehört zu den Bärenspinnern (Arctiidae). In Europa sind die *Spilosoma*-Arten seine nächsten Verwandten. *Hyphantria* ist in den Vereinigten Staaten und in Canada einheimisch.

Die Beschreibung und die Lebensweise des Schädling ist die folgende:

Die Spannweite der Flügel liegt bei dem Schmetterlinge zwischen 25—30 mm. Die Körperlänge des Männchens liegt bei 11, die des Weibchens bei 15 mm. Die Farbe

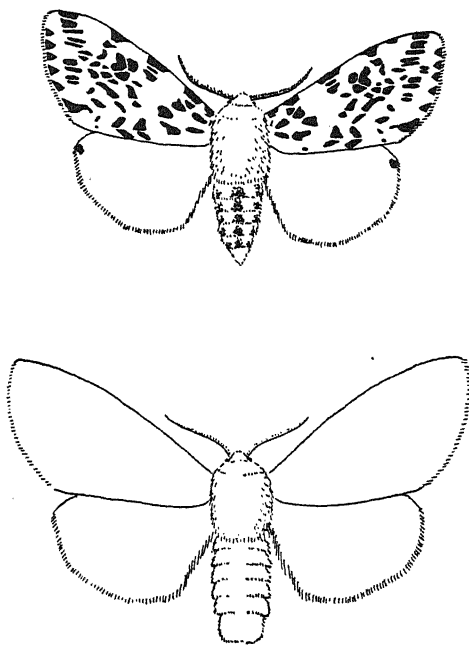


Abb. 1. Oben Männchen von *cunea*-Typ, unten ein Weibchen von *textor*-Typ. (2,5 x)

des Körpers und der Flügel ist in Ungarn meistens ganz weiss. Diese Spielart ist also gegenüber der Formen mit schwarzer Zeichnung, welche Artsspezifisch sind, viel verbreiteter. Die Weibchen sind in überwiegender Zahl ganz weiss, aber unter den Männchen können alle Uebergangsformen vorkommen. (Abb. 1.)

Die Eier sind grünlichblau, 0,5 mm im Durchmesser. Das Weibchen legt alle seine 6—700 Eier auf einmal ab und zwar zumeist auf die Blätter der Triebspitzen. Die Eier werden mit den vom Hinterleib abgestreiften, weissen Flocken spärlich zugedeckt.

Die Eiraupe ist vorerst fast ohne Zeichnung, ihre Farbe ist blass buttergelb. Die Warzen der Jungraupe sind grauschwarz. (Abb. 2.)

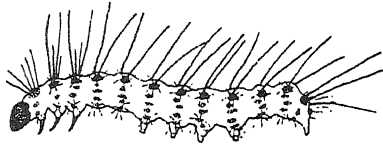


Abb. 2. Eiraupe. (10 x)

Die ausgeschlüpften Raupe beginnen sofort ihre Spinnfähigkeit und von da an werden die zur Ernährung dienenden Blätter immer vorerst ins Raupennest eingesponnen. Die Blätter werden beim Frass vorerst nur skelettisiert, dann durchlöchert. Später aber lassen die Raupe nur noch die Blattstiele übrig. Die skelettisierten und abgeschabten Blätter vertrocknen bald und vergilben. Man kann also die Raupennester nach den verfärbten Blätter an Astspitzen ziemlich früh wahrnehmen obschon das Gespinnst meistens sehr fein und kaum sichtbar ist. Das Gespinnst ist aber doch so dicht und so stark, dass die Raupe dadurch von allen äusseren Einwirkungen, insbesondere von Feinden und ungünstiger Witterung beinahe ganz geschützt sind. Das sich immer erweiternde und ausbreitende Raupennest erstreckt sich nach ein oder zwei Wochen auf ganze Äste und kann sich auf die anderen Äste ausdehnen. Die Raupe ernähren sich unter dem Schutz des Gespinnstes am meisten nur abends oder nachts und häuten sich im Nest, wo auch der Kot bleibt.

In Amerika leben die Raupe bis zur Verpuppung in Raupennestern und verlassen es nur nachts um sich zu ernähren von den Blättern in der Umgebung des Nestes. In Ungarn aber leben die Raupe nur bis zum letzten Drittel ihres Lebens im Raupennest, worauf ihre Spinnfähigkeit aufhört. Die Raupe verstreuen sich dann auf der primären Nährpflanze oder kriechen auf andere Pflanzen.

Die ausgewachsenen Raupe sind 35 mm lang, dicht behaart. Die Körperfarbe zeigt auf blassgelbem Grunde graue bis schwarze Zeichnungen und Schattierungen. Die Mittellinie des Rückens, welche die grossen Warzenpaare begrenzen, ist meistens dunkelgrau. Die Farbe der Raupe variiert auch ziemlich stark und manchmal sind auch ganz gelbe Raupe zu finden. (Abb. 3.)

Die Raupe sind nach 4—6 Wochen ausgewachsen, dann verpuppen sie sich in einem Versteck, zumeist in den Ritzen des Stammes, unter Rindenschuppen, in Ritzen und Spalten von Pfählen, Zäunen, Gebäuden und Holzhaufen, zwischen Steinen und Moos, in dürrer Laub und Reisig und zwischen Erdschollen und Erdspalten. Der Kokon ist im Durchschnitt 20 mm lang und besteht aus einem spärlichen Gespinnst, welches mit Haaren gemischt ist.

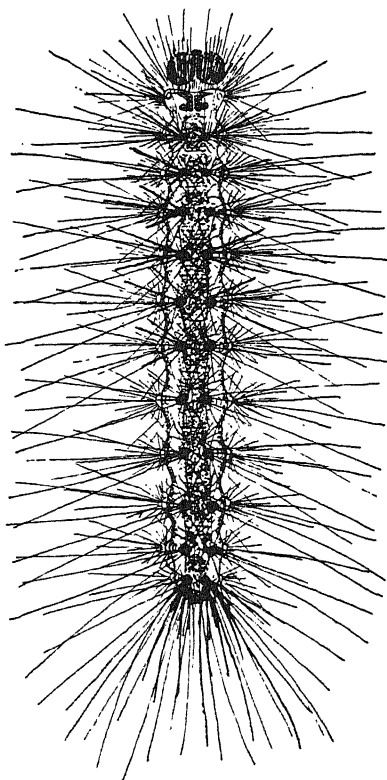


Abb. 3. Ausgewachsene Raupe. (3 x)

Die Überwinterung geschieht im Puppenstadium. Die Puppenruhe im Sommer dauert aber nur 8—10 Tage. Die Schmetterlinge verlassen die Puppenhülle immer am Abend, die meisten eine Stunde vor Sonnenuntergang. Die Schmetterlinge fliegen nur im Dunkel. Im Flug haben sie keine Ausdauer und für ihre Verbreitung spielt der Wind, also der passive Flug eine grosse Rolle. Die Schmetterlinge leben 10—14 Tage lang.

Der Schädling hat in Ungarn immer zwei Generationen, in Amerika dagegen in den nördlichen Teilen der Vereinigten Staaten und in Canada nur eine. Die Hauptflugzeit der Schmetterlinge in Ungarn ist April—Mai und Juli—August. Die Zeitdauer einer Generation ist im Sommer drei Monate lang. Die Entwicklungszeit der verschiedenen Stadien kann sich aber so verzögern, dass in der zweiten Hälfte des Sommers fast alle Entwicklungsstadien zur gleichen Zeit zu finden sind. Wenn der Herbst trocken und warm ist, dann konnten wir auch eine spärliche, dritte Schmetterlingsgeneration beobachten. (Abb. 4.)

Von der Schädlichkeit der *Hyphantria*-Raupen sprechend haben wir vorerst festzustellen, dass diese Art weitgehend polyphag ist. In Amerika hat man die Raupen an 120 Arten von Wirtspflanzen gefunden und in Ungarn konnten wir bereits ungefähr 60 Nährpflanzen registrieren. Das Weibchen legt seine Eier am liebsten auf die Blätter des Maulbeerbaumes (*Morus alba*) und des Eschenachorns (*Acer negundo*). Wir konn-

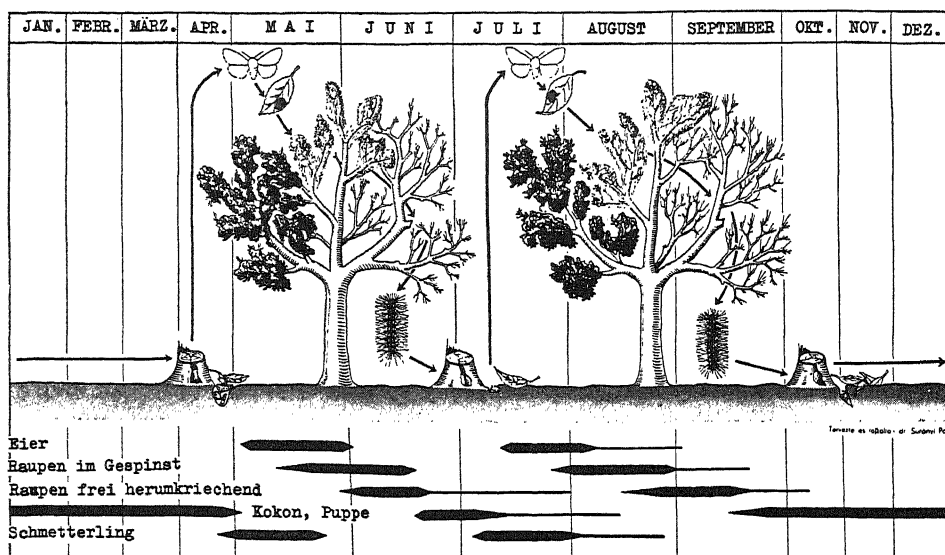


Abb. 4. Lebenslauf und Generationen von *Hyphantria cunea* in Ungarn.

ten ferner die fressenden Raupen an allen Obstbäumen, an den meisten Waldbäumen und an vielen Zierbäumen und -Sträuchern beobachten. Auch Unkräuter werden gefressen (z. B. *Urtica*), und wenn alle Nahrung fehlt, dann werden die Raupen kannibalisch.

Die Liste der bisher gefundenen Wirtspflanzen von *Hyphantria*-Raupen ist die folgende:

#### Nutzpflanzen:

*Morus alba*  
*Morus nigra*  
*Prunus avium*  
*Prunus domestica*  
*Prunus instititia*  
*Prunus cerasus*  
*Prunus persica*  
*Prunus armeniaca*  
*Prunus amygdalus*

*Pirus sativa*  
*Malus pumila*  
*Cydonia oblonga*  
*Juglans regia*  
*Corylus avellana*  
*Vitis vinifera*  
*Brassica oleracea*  
*Armoracia lapathifolia*  
*Humulus lupulus*

#### Waldbäume, -Sträucher und Alleeabäume:

*Acer negundo*  
*Acer pseudoplatanus*  
*Acer platanoides*  
*Quercus* spp.  
*Populus virginiana*  
*Populus italica*  
*Populus alba*  
*Salix* spp.  
*Alnus glutinosa*  
*Ulmus foliacea*  
*Ulmus scabra*

*Ailanthus glandulosa*  
*Fraxinus excelsior*  
*Tilia platyphyllos*  
*Tilia cordata*  
*Robinia pseudacacia*  
*Colutea arborescens*  
*Crataegus monogyna*  
*Crataegus oxycantha*  
*Sambucus vulgaris*  
*Ligustrum vulgare*

*Zierbäume und -Sträucher:*

<i>Syringa vulgaris</i>	<i>Tecoma (= Campsis) radicans</i>
<i>Lonicera xylosteum</i>	<i>Parthenocissus quinquefolia</i>
<i>Symphoricarpos racemosa</i>	<i>Salix babylonica</i>
<i>Deutzia</i> sp.	<i>Platanus acerifolia</i>
<i>Diervilla rosea</i>	<i>Celtis australis</i>
<i>Philadelphus</i> sp.	<i>Cotoneaster</i> sp.
<i>Spiraea triloba</i>	<i>Eleagnus angustifolia</i>
<i>Cercis siliquastrum</i>	<i>Joxylon pomiferum</i>
<i>Rosa</i> spp.	<i>Aesculus hippocastanum</i>

*Unkräuter:*

<i>Polygonum aviculare</i>	<i>Urtica dioica</i>
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Die Bäume und Sträucher leiden sehr unter dem Frass der *Hyphantria*-Raupen weil das Laubwerk beinahe oder völlig vernichtet wird. Voriges Jahr (1947) wurden schon in manchen Gegenden die Maulbeeralleen kilometerweise ganz kahlgefressen und auch Obstbaumbestände arg beschädigt.

Auch die sekundären Schäden sind sehr beträchtlich, weil nach solchen Frassbeschädigungen die Bäume nocheinmal austreiben. Die neuen Triebe können nicht ausreifen und die Pflanzen werden durch die Winterfröste arg mitgenommen oder gehen sogar zugrunde.

Die Gefährlichkeit des Schädling wird durch die, von Jahr zu Jahr sich steigende Verbreitungsintensität noch erhöht. Im gegensatz zu 1946, wo der Schädling nur in der weiteren Umgebung von Budapest zu finden war, verbreitete er sich im Jahre 1947 über drei Viertel von Ungarn. *Hyphantria* hat also in einem Jahre nach manchen Richtungen sogar Strecken von 100 km zurückgelegt.

Die Verbreitung auf weitere Strecken ist ausser durch den Wind auch mit Transportmitteln möglich, weil die Raupen zur Verwandlung ein Versteck aufsuchen und sich auch in stationierten Verkehrsmitteln verkriechen und verpuppen können.

Die Eigenschaften von *Hyphantria* und die von den Raupen verursachten Schaden lassen darauf schliessen, dass wir einem der schlimmsten Schädlinge gegenüberstehen. Es besteht ohne Zweifel die Gefahr, dass *Hyphantria* in Europa sehr schwere Kalamitäten herbeiführen kann.

In Europa hat *Hyphantria* ähnliche oder noch günstigere klimatische Verhältnisse und fast gleiche Wirtspflanzen. Noch wichtiger und wesentlicher ist aber die Tatsache, dass hier die originellen natürlichen parasiten dieses Schädling gänzlich fehlen. Die *Hyphantria*-Raupen werden in Nordamerika von 46 Arten Schmarotzerinsekten parasitiert. Diese, zum Teil oligophagen Parasiten begrenzen in Amerika die Vermehrung dieses Schädling, dass er sich nicht unumschränkt vermehren kann. Wir haben sehr viele Züchtungen bemacht und wir konnten es feststellen, dass die *Hyphantria*-Raupen von den europäischen Parasiten nur gelegentlich befallen werden.

Die künstlichen Bekämpfungsmassnahmen können das Fehlen der Parasiten nicht ersetzen. Die Bekämpfung der *Hyphantria*-Raupen ist überhaupt schwierig, weil sie gegen die meistgebrauchten Insektizide ausserst widerstandsfähig sind. Mann muss gegen die älteren Raupen von Magen- und Nervengiften (also von Arsen bzw. DDT) 2—3fache Konzentrationen verwenden, wodurch aber die Pflanzen (z. B. von Arsen) geschädigt werden könnten. Auch die anderen Methoden (z. B. das Abschneiden der

Raupennester) sind wegen der grossen Verbreitung des Schädling und der vielen Nährpflanzen nicht immer durchführbar.

Die entgültige und befriedigende Lösung dieses Problems können wir hauptsächlich von der biologischen Bekämpfung erhoffen. Offenbar ist die Gedanke, die Parasiten von *Hyphantria* nach Europa einzuführen, die einzige Möglichkeit, um den Schädling wirksam zu bekämpfen. Jetzt ist dieser Schädling gewissermassen noch auf einige Jahre ins Karpathenbecken eingeschlossen und in einem begrenzten Raum macht die biologische Bekämpfung am meisten Erfolg.

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## RECENT PROGRESS IN LOCUST AND GRASSHOPPER RESEARCH

By B. P. Uvarov

The economic importance of locusts and grasshoppers has always been very great, but it is only during the last 20 years that our knowledge of these insects has developed to a degree when it becomes possible to see the whole problem more clearly. These advances in their study are due to the researches organised in a number of countries particularly in Great Britain, France, Belgium, The United States, Canada, India, Egypt, South Africa, and Australia. It would be impossible in this short review to summarise all recent advances in our knowledge, and only the outstanding trends will be mentioned.

The taxonomy and distribution of locust species is now well known, and every locust has been found to present two phases—solitary and gregarious. There are no exceptions to this and the phase phenomenon is no longer under dispute. Systematics of grasshoppers (that is of non-swarming Acrididae) are in a less satisfactory state, and recent extensions of mechanised agriculture into the tropics are bringing to light many injurious species which are little known to the taxonomist, or even quite new.

Fair progress has been made in anatomical study of Acrididae, but there is still much to be done, especially in comparative anatomy of different groups, since so many generalisations have been built on the basis of studying very few examples, not necessarily typical.

The study of Acridid physiology is only beginning, and such advances as have been made are mainly due to the fact that some species, (notably *Melanoplus differentialis* of North America) have proved to be convenient laboratory animals. They are often used for all kinds of general physiological work, which results mainly in the accumulation of disjointed data. The most numerous are the physiological studies on egg diapause, but they are still far from solving this problem. The crying needs in this direction are fundamental studies on nutrition, metabolism and the senses, particularly vision. A very limited and inexact knowledge of sensory physiology stands in the way of a better understanding of behaviour, although in this respect some advances have been made recently both by field studies and, to a lesser extent, by laboratory experiment.

It is in the ecological field that recent progress has been particularly notable, and it is definitely greater with regard to locusts than to grasshoppers. The reason for this is that injurious grasshoppers usually occur in mixed populations of several species and are often studied as a "community". The result is that ecological characters of individual species are confused and no clear picture is obtained. Locusts, on the contrary, are studied as single species, easily recognisable in the field, and the results are not obscured. An outstanding result of ecological studies, both on locusts and grasshoppers, is that in most cases they present a man-made economic problem. It used to be thought that grasshoppers and particularly locusts were favoured by conditions of undisturbed natural environment, that they bred in steppes and deserts and invaded cultivated areas, only occasionally. It followed that the grasshopper and locust problems should have disappeared once a country became fully developed. This theory had no foundation in fact and it has now been finally established that it is generally not true. The expansion of agriculture may be unfavourable to some species of Acrididae,

but there are always some others which are favoured by it and which speedily become pests. Agricultural development in North and South America, Siberia, Australia, and Africa has everywhere brought with it the emergence of grasshoppers and locusts as major pests, and their number is steadily growing.

The pest status is acquired by an insect mainly because of its excessive numbers. The numbers of grasshoppers and locusts are subject to sharp fluctuation and the irregular periodicity of plagues is their outstanding feature. Studies in periodicity based on correlation with sun-spots etc. are now giving way to thorough ecological studies, but these are still far from solving the problem. In the case of locusts, great advances in the study of plague periodicity have become possible with the application of the phase theory, since the swarming (gregarious) phase of locusts, which manifests itself during the height of the plague, is strikingly different morphologically and physiologically from the solitary phase so that the problem is not one of numerical fluctuation only. The factors responsible for the transformation of the solitary into the gregarious phase are not yet fully understood, but it is clear that they are essentially ecological. This gives a definite hope that, once the ecological factors favouring transformation in a given species are known, it should become possible to alter these conditions and thus to prevent locust outbreaks. The prevention of outbreaks on an ecological basis is becoming the ideal aim of acridologists, since it offers the only hope for the final solution of the problem, all other methods of locust control being mere palliatives.

A well known feature of locust biology is migration. This phenomenon has been long wrapped in mystery but recently objective methods of cartographic analysis, combined with field observations on behaviour, have shown that migrations, often carrying swarms over hundreds of miles, are closely dependent on weather factors and the major trends normally depend on wind directions. No evidence of movement directed towards better food supplies or favourable breeding grounds has been found and it becomes possible to study, and even to forecast, locust migrations with the aid of synoptic meteorology. This approach will, no doubt, have a wide application in the study of insect migrations in general.

It will be seen from this very brief review that work on locusts and grasshoppers is making rapid progress. This is due mainly to the realisation by governments that this great problem can only be solved as a result of organised research aiming not merely at achieving quick temporary success, but at a thorough understanding of the problem. Another important factor in this progress has been the unusual degree of international co-ordination in locust investigations, which has made it possible to study each locust over its whole area, instead of restricting the work to a single country. At present, there are specialised locust research organisations in most of the countries suffering from these pests and there is every hope that the oldest entomological problem is approaching its solution.

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## THE PLUM BORER (*Rhynchites cupreus* L.) AS A PEST IN FINLAND

By Niilo A. Vappula

In the genera *Rhynchites* and *Coenorrhinus* there are several noteworthy fruit-tree pests, of which the species *Rh. cupreus* L., *Coenorrhinus tomentosus* Gyll., and *C. aequatus* L. belong to the fauna of Finland. Of these only the first-mentioned is observed to occur as a pest in this country.

*Rhynchites cupreus* L. is a very wide-spread species, which, according to Winkler (1924—1932), is found in Europe, Siberia and Japan. Damage to fruit-trees caused by it has been observed at least in Germany, France, Switzerland, Italy and Russia, as well as in Transcaucasia, Turkestan, and possibly also in Japan. In Northern Europe this species has been found as a pest in Sweden, Norway and Finland. Also in England damage, caused possibly by this species, is reported by Theobald (1909).

According to investigations made in Germany (Jancke 1935) the host plants of this weevil are only the plum-tree (*Prunus domestica*) and the cherry-tree (*Prunus cerasus* and *Pr. avium*). In places it seems to prefer the cherry-tree, whilst on the other hand, in other places the plum-tree is its main host plant. The same seems to be the case in most other countries, too. In the spring the weevils which have hibernated injure the buds which have not yet opened, young leaves, flower stalks, flowers and green fruits. The greatest damage, however, is caused by females, which almost completely cut the base of the green fruit and afterwards lay their eggs in the hole which they have bored in it. According to some previous investigators the weevil can also live on *Sorbus torminalis* and *S. aucuparia*, hazel, birch, *Crataegus* spp., and so on. Damage to buds and flowers is reported by Schreiner (1914) in apricot- and apple-trees amongst others. As is explained in what follows, this species occurs in Northern European countries, e.g., Sweden, Norway and Finland, as a noteworthy pest on the apple-tree, damaging the green fruits as well as the tops of the shoots.

In Finland C. R. Sahlberg mentions this species for the first time in 1834 in his work "Insecta Fennica". He reports the weevil living on the leaves of the birch, mountain ash and hazel ("Habitat in foliis Betulae, Sorbi et Coryli, sat frequens"). Nowadays, *Rh. cupreus* is a rather common species in Southern and in Middle Finland to about latitude 64° north. As a pest, it was noticed for the first time in the eighteen-eighties in Mustiala, where it caused large-scale damage to apple-trees, gnawing the base of the green fruits when they were the size of a nut, and thus causing them to drop (Stening 1906). The same author reports this species in the years 1894—1904 in the garden and in the nursery of Mustiala College, as having also caused injury of another kind to apple-trees, affecting young first-year shoots. The weevil bites the young shoots off in the early summer, when they are still soft, having previously laid its eggs in a hole which it has bored in the shoot. He mentions the species as having occurred very numerously in some years, and having caused much trouble to the gardener by its depredations.

In the report of the State Entomologist the species is mentioned for the first time in 1913 (Linnaniemi 1915), when it appeared in a garden in the southernmost part of the country on plum-trees as well as on apple-trees, causing in them the dropping

of green fruits and so diminishing the fruit harvest considerably. In the years 1915—1916, damage occurred in the southern part of the country, in places even very severely, on the first-year shoots of young apple-trees, more rarely on the shoots of plum-trees. By means of breeding experiments it was finally discovered that the shoot damage is also caused by *Rh. cupreus*.

After an interval of many years, injury began to occur in the nineteen-thirties to a rather considerable degree almost only on apple-trees. According to the reports received, damage has been most wide-spread in the years 1932—1933, 1935—1936, 1938—1939, and 1944—1946. Chiefly it has been noted in the south of Finland to latitude 62° north, but some cases have also appeared further north, as far as in Oulainen. In Sweden, also, *Rh. cupreus*, and with it *Coenorrhinus tomentosus* Gyll., are mentioned as damaging the shoots of the apple-tree, the pear-tree and the plum-tree (Tullgren 1929, Lindblom 1936 and 1941), although large-scale damage has been rather rare. In Norway, injury was noticed for the first time in 1932, when the weevil damaged the green fruits of the plum and apple, cutting their stalks. Later on damage has occurred there to the young first-year shoots and leaf stalks (Schøyen 1934 and 1941).

The weevils that have hibernated usually appear in early June. Maturation feeding, which according to Jancke (1935) affects the buds, young leaves, flower-buds and green fruits of plum- and cherry-trees, has not been observed in Finland. Egg-laying does not generally begin until the middle of June, when the first reports of the damage arrive, or towards the end of the same month, and continues at least during July. The female lays its eggs in the soft first-year shoot of an apple-tree, and then cuts the shoot off at some distance below the point where the eggs were laid, so that it very easily drops to the ground. The length of the cut shoot varies between 5—15 cm. Damage of the same kind is caused in Central Europe and England by another species, the apple twig cutter, *Rhynchites coeruleus* D.G. Most reports on shoot damage by the plum borer arrive in early July, but in some years damage has still been noticed in early August. Especially in apple-tree nurseries and in young, recently-planted apple orchards, the cutting of top shoots caused by the weevil is very harmful, because as a result the shoots change into 2—3-branched ones, which makes the growing of well-formed trees difficult. In the worst cases the trees can hardly grow at all but turn into strange dwarfs, when the first-year shoots are cut off as fast as they grow. Only seldom damage has been noticed in older trees. Especially in recent years the plum borer has appeared as a very severe pest. Thus it was, for example, reported from Joutsa in 1944 that in an orchard, where about 150 young apple-trees were growing, for many years the top shoot had bitten off in nearly all the trees. In another orchard, consisting of 100 young trees, the weevil is mentioned as having cut all the first-year shoots so completely that it was impossible to find a single undamaged shoot-tip, only cut-off stumps round the tree. Rather seldom the shoot injury has been observed in plum-trees, and still more rarely in cherry- and pear-trees. Sometimes in the mountain ash trees (*Sorbus aucuparia*) cut-off shoots are seen, damage which, in the author's opinion, is caused by the plum borer, although no breeding experiments have been made up to now. Earlier Nördlinger (1869) has reported similar observations, which Jancke (1935), however, regards as unreliable. It must be mentioned that, according to an observation by O. Savas, the weevils appeared in one place in Helsinki on mountain ash trees numerous, there being more than 50 specimens on a quite small sapling even, and the leaves of the mountain ash were eaten away

like a sieve. In one case, cut-off shoots have been observed also in a young whitebeam (*Sorbus aria*), the damage having probably been caused by this pest. Injury of the same kind has been observed once on hawthorn (*Crataegus* sp.) and on June berry (*Amelanchier canadensis*).

As was mentioned before, the plum borer causes damage to apple- and plum-trees also by nearly cutting off the base of the green fruits in connection with egg-laying, so that these easily drop to the ground. Damage of this kind does not seem to be as common as the injury done to the shoots. It is true that the damage to green fruits very easily escapes notice, owing to the dropping of green fruits due to other causes, too. In apple-trees, especially, the weevil thus causes large-scale injury. In some cases it is observed to have caused nearly all green fruits to drop as well as the shoot-tips, and in one case about 50 % of the green fruits were destroyed. On plum-trees, which are grown in lesser numbers in Finland, the dropping of green fruits caused by the weevil has been noticed in a considerable degree only in one place, where in an orchard it destroyed 90 % of the yellow plums, leaving other varieties of plum untouched.

In addition to the dropping of shoots and green fruits, the plum borer, when appearing in great numbers, causes damage also to the developing green fruits remaining on the trees, and also to quite large apples, digging holes in the surface of the fruit, which later on become corky (Fig. 1). Injury of this kind was observed for the



Fig. 1. Apples injured by the plum borer.

first time in 1932, but especially in 1935 the weevil caused quite considerable damage in many places (Hukkinen and Vappula 1936). Thus in some cases it damaged 50—60 % of the fruits so badly that the market value of the apples fell considerably. Also later on, damage of the same kind has appeared at times on a large scale. Sometimes injury occurs already in the latter part of June on young green fruits, but it is found most numerously in July and August. In two cases white curculionid larvae were found in the damaged fruits, but it was not possible to identify the species, breeding being unsuccessful.

According to the material collected, 95 % of all cases of damage have involved apple-trees and only 5 % plum-trees; therefore *Rh. cupreus* L. is to be regarded in

Finland as a pest chiefly of the apple-tree. As stated above, it causes the greatest injury to young apple-trees, cutting off top-shoots, but it can also cause considerable damage by severing green fruits and damaging ripening apples.

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## SUR TROIS INSECTES D'IMPORTANCE ÉCONOMIQUE ENCORE PEU CONNUES EN AFRIQUE FRANÇAISE

Par P. Vayssière et H. Galland

I. — Au mois de Novembre 1947, le chef de la Station rizicole expérimentale de Kayo (par Macina) Soudan français, M. Vincent, nous expédiait à fin de déterminations, quelques insectes prédateurs du riz, récoltés dans les plantations.

Deux d'entre eux sont nouveaux pour l'Afrique française et il importe de connaître leur biologie et les moyens de lutte appropriés adoptés dans les autres Pays, afin d'éviter leur pullulation et de préserver les récoltes.

a) *Pachytiplosis oryzae* (Wood Mason).

Sur la Cécidomyie, *Pachytiplosis oryzae*, M. Vincent a fait les observations suivantes : "... Les insectes se manifestent sur les jeunes plants de riz déficients et chlorotiques, de Juin à Septembre. Dans les plants de vigueur normale, il n'y a pas, ou très peu, de parasitisme. ... On remarque l'attaque de ces insectes par l'apparition de "tiges rondes" plus hautes que les autres feuilles et plus pâles encore; la tige ronde n'est autre chose qu'une feuille enroulée, les bords étant soudés jusqu'à une dizaine de centimètres du sommet : à cet endroit la feuille est généralement vrillée. A ce stade on ne trouve dans la tige ronde que des pupes plus ou moins avancées. L'insecte parfait émerge de la tige au point de transition entre le "tube" et le "vrillage". Aucun autre orifice n'a jamais été constaté".

La description de la plante parasitée est typique, la larve produisant la maladie appelée "silver shoot", il se développe à la place de l'épi une longue pousse creuse d'un vert grisâtre dans laquelle évolue et se nourrit la larve, puis la pupa qui peut même se déplacer à l'intérieur de cette galle tubulaire. L'adulte s'échappe par un trou percé vers le haut. Les adultes sont de mœurs nocturnes et les femelles déposent leurs œufs isolément ou par groupe sur le limbe des feuilles du riz et peut-être aussi de quelques autres graminées. Le cycle est assez court, (de 22 à 42 jours dans la Chine du Sud<sup>1</sup>) et plusieurs générations se succèdent s'attaquant tour à tour aux différentes variétés de riz; quand une variété approche de la maturité, l'atteinte de la suivante commence. Ce sont les larves qui hivernent dans les chaumes.

Jusqu'à maintenant l'insecte n'avait été signalé qu'en Asie (Chine, Inde, Ceylan, Siam, Birmanie, Indochine française) et aux Indes Néerlandaises où il produit parfois de gros ravages; il est connu sous le nom générique de "Rice gall midge". La détermination de nos échantillons a été confirmée par notre ami Barnes (Rothamsted experimental Station).

Aux Indes<sup>2</sup>, les moyens de lutte conseillés consistent en la prise des adultes au moyen de pièges lumineux. Des méthodes culturales ont été utilisées aussi de façon à stimuler la croissance des plants et à augmenter leur résistance. Au Tonkin<sup>3</sup>, il est recommandé de détruire, avant la pupaison, tous les pieds attaqués facilement reconnaissables ainsi

<sup>1</sup> Yen, Liu, Kuo: A preliminary study on life history of the Rice Steus Midge, G.O. (Cecidomyiidae) in Kwangsi Province, South China.

<sup>2</sup> Agriculture and Animal Husbandry in India, 1938—39. — Annual Report of the Imperial Council of Agricultural Research, 1940—41.

<sup>3</sup> Nguyen-Cong-Tieu. — Note sur une Cécidomie du riz (*P. o.*), *Bull. écon; Indochine*, XXV, N° 156, p. 590—3.

que plusieurs espèces de *Panicum* qui sont sans doute des plantes-hôtes. Enfin, larves et pupes sont parasitées par des Chalcidoïdes, dont il serait intéressant de préciser la présence et le rôle au Soudan.

b) *Laphygma exempta* Wlk.

Cette petite Noctuelle a été déterminée par N. Hallé. D'après M. Vincent, elle s'attaque aux variétés de riz à grosses tiges. L'apparition se manifeste en Octobre—Novembre pendant l'épiaison: tout l'intérieur du chaume étant détruit, les panicules apparaissent stériles et complètement blancs. On remarque très bien l'orifice d'entrée, les dégâts et les déjections de l'insecte.

Elle est connue dans tous les territoires anglais d'Afrique (Sierra Leone, Tanganyika, Kenya, Afrique du Sud), aux Iles Hawaïi et à Java où elle endommage gravement toutes les céréales: blé, maïs, riz, sorgho, etc. . . , la canne à sucre et d'autres graminées fourragères ou sauvages. Les chenilles, comme celles des *Leucania*, sont parfois désignées sous le nom de "army worm", car elles peuvent être si nombreuses qu'elles constituent de véritables armées migratrices. Nous rappelons en outre que des travaux récents ont mis en évidence, pour cette espèce, l'existence de phases, comparables à celles des acridiens: solitaria, transiens, gregaria chez lesquelles la teneur en acides lactique et urique et le pH du sang sont différents. Nuit et jour, les chenilles, les jeunes surtout, rongent les pousses, détruisent les feuilles, passant d'un champ dans un autre, dès que la nourriture leur manque. Dans toutes les régions infestées, de gros dégâts sont constatés, les jeunes plantes étant plus particulièrement touchées et les pieds mûrs restant indemnes.

Les adultes volent à la nuit et les œufs sont déposés en masses irrégulières sur les feuilles des plantes-hôtes des chenilles. Le stade larvaire dure de 15 jours à un mois et la chrysalidation a toujours lieu dans le sol à la racine des plantes.

Il a été remarqué<sup>4</sup> que les invasions graves suivent une saison très humide et chaude qui a permis le développement d'herbes fraîches et succulentes favorisant la croissance des jeunes chenilles qui exigent une nourriture abondante. L'apparition et la disparition soudaines d'une infestation dans une localité laissent aussi croire à une migration des adultes. Mais la présence de l'insecte est souvent constatée sans qu'il y ait grave attaque et par conséquent sans qu'il ait une importance économique.

Beaucoup de moyens de lutte ont été essayés dont les résultats sont contradictoires: appâts empoisonnés à l'arséniate de sodium ou au vert de Paris; tranchées ou lignes creusées verticalement pour arrêter l'avance des chenilles. On obtint toujours une forte mortalité par les pulvérisations à l'arséniate et au fluosilicate de sodium ou de baryum. Les parasites naturels, Braconides et Chalcidides, quoique nombreux et efficaces, ne sont pas suffisants pour la destruction des chenilles et nulle recherche n'a été entreprise à ce sujet.

Il semble donc qu'une étude biologique de l'insecte doit être faite au Soudan français et qu'il serait bon de surveiller attentivement, les plantations afin de prévenir toute invasion de ce parasite qui serait si nuisible au riz et autres graminées.

J. Risbec et H. Alibert<sup>5</sup> ont eu l'occasion de déterminer cet insecte en A.O.F. ou il pullule sur le Riz et autres Graminées.

<sup>4</sup> Evans: Pasture, crop and insect problem of the Union, Annual report of the division of plan industry; *Farm. in S. Afr.*, 1938, repr. N° 105, 20 p. — Hattinigh C. C.: The biology and ecology of the army worm *L. e.* and its control in South Africa; *Sc. Bull. Dep. Agric. for S. Afr.*, n° 217, Pretoria 1941.

<sup>5</sup> Nalla maire A.: Les animaux prédateurs et les insectes parasites des Riz cultivés en A. O. *L'Agronomie tropicale*, vol. IV, N° 1—2, p. 73, 1949.



II. — Lors d'une mission de l'un de nous au Cameroun, en 1945-46, il lui fut signalé, dans la région de Foumban, que les plantations de Caféiers d'Arabie situées dans les parties les plus basses à proximité du Noun dépérissaient et mouraient à la suite d'attaques de larves mélolonthides ou "vers blancs". Il était certain que la détermination faite en 1942 comme *Rhizotrogus solstitialis*, sous prétexte que cet insecte causait des dégâts comparables dans la région de Rouen, était inexacte. Les échantillons que nous avons récoltés nous ont permis de les identifier facilement à *Heteronychnus claudius* Klug, nommé aussi *Heteronychnus* (= *Heteroligus*) *meles*, coléoptère de la famille des Dynastidae.

La pullulation dans les régions indiquées fut extraordinaire ces dernières années, les larves se rencontrant presque exclusivement dans les terrains humides (terres noires) en particulier le long de la vallée du Noun; elles rongent de préférence le collet des jeunes Caféiers, surtout au cours de la première année de culture, lorsqu'ils sont âgés d'au moins sept mois. Jusqu'à 90 % des jeunes plantations ont été détruites. C'est ainsi qu'un agent des plantations Mallet, M. Chauvet, a récolté en 1944, 200 vers blancs sur 6 m<sup>2</sup>, soit 35 tonnes sur 32 Ha. Il semble qu'il n'y ait qu'une génération par an et que le maximum d'adultes se rencontre de fin septembre à fin octobre.

L'insecte avait été signalé déjà en Guinée française<sup>6</sup> où ses larves très voraces y détruisaient les bananiers en plantation, en coupant et dévorant les racines. Là aussi, c'est dans les régions humifères qu'elles se trouvaient en abondance, 10 à 30 avaient été ramassées près de chaque souche. Il semble que leur période active de destruction ne dure que de 15 à 25 jours, c'est-à-dire pendant le temps qui précède la nymphose. On préconisait le ramassage des larves et, l'année suivant l'infestation, le poudrage au sulfure de calcium qui est ensuite enfoui par binage des zones envahies; de bons résultats avaient été obtenus. Aucune constatation n'a été faite quant aux dégâts par les adultes.

En Nigeria (les larves du même Dynastide causaient de sérieux dégâts dans les plantations d'Igname ("Yam") pouvant aller jusqu'à la destruction totale des récoltes. Les invasions ne se reproduisant pas toujours plusieurs années de suite dans un même district, on put supposer<sup>7</sup> que des migrations des adultes s'étaient produites. L'habitat des larves était toujours là où l'humidité est la plus forte : les ignames poussant dans les vallées près des rivières étaient plus atteints que ceux des régions élevées et bien drainées. Les hannetons apparaissaient au début des pluies et disparaissaient en Octobre, l'attaque étant maximum en Juin et Juillet. Des expériences de laboratoire ont montré que les œufs sont déposés dans le sol à des profondeurs variées, chaque femelle pondant 40 œufs environ, les stades d'œuf, de larve et de pupa dureraient respectivement : 12 à 26 jours, 93 à 141 jours, 13 à 20 jours. La capture des adultes au moyen de pièges lumineux fut inefficace,<sup>8</sup> par contre les dommages furent réduits grâce à la destruction des vers blancs par exposition au soleil et battage des vieux ignames. Dans la même province, des larves furent trouvées sur des racines d'herbes et des semailles d'*Arachis hypogaea*.

En Côte d'Ivoire, Alibert l'a récolté sur *Elaeis guineensis*.

<sup>6</sup> Chevalier A.: Note sur un coléoptère du genre *H.* causant des dégâts aux bananiers en Guinée française. *Rev. Bot. appl.* n° 185, p. 65, 1937. — Annet E.: Note sur les dégâts causés aux bananiers par *H. c.*, *Rev. Bot. appl.*, n° 222, pp. 119-121, 1940.

<sup>7</sup> Lean: Experiments on the life history and control of the Yam beetle in the Benue Province of Nigeria; 8° *Ann. Bull. Agric. Dept. Nigeria* 1929, pp. 43-47.

<sup>8</sup> Lean: A dynastid beetle as a serious pest of Yams in the Benue Province of Nigeria; 7th *Ann. Bull. Agr. Dept. Nigeria*, pp. 45-46, Lagos, 1928.

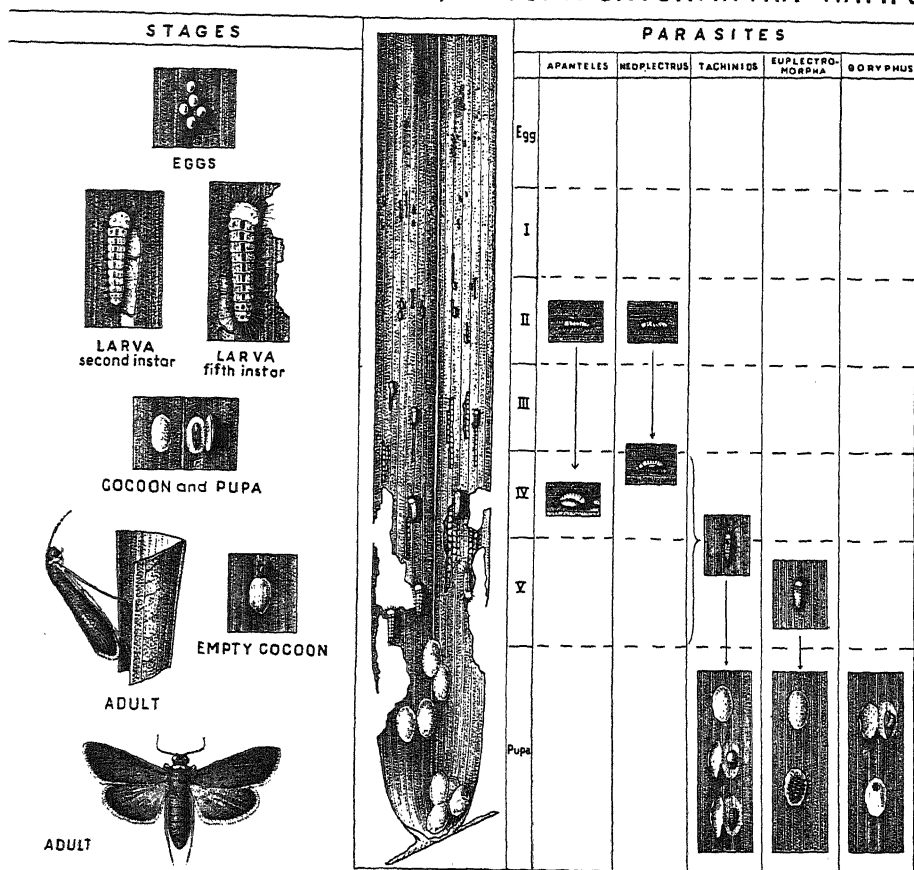
# POPULATION STUDIES ON THE COCONUT LEAF MOTH *Artona catoxantha* HAMPS. (LEP., ZYG.)

By J. van der Vecht

The Zygaenid moth *Artona* (*Brachartona*) *catoxantha* Hamp. is a notorious pest of the coconut palm in the Malay Peninsula and on many islands in the Western half of the Indonesian Archipelago.

All early stages of this insect are found on the underside of the leaves of the food plant (fig. 1). The duration of the life cycle, from oviposition to emergence from the pupa, is about 5 weeks (egg 5 days, five larval instars together 18—21 days,

## THE COCONUT LEAF MOTH, *ARTONA CATOXANTHA* HAMPS.



"Fig. 1. Eggs 3 x; larva second instar 5 x, do. fifth instar 1.5 x, cocoon and pupa 0.3 x, adult 2 x. Central figure (coconut leaflet with successive stages of *Artona*) and parasites 0.3 x."

prepupa 2 days and pupa 8 days). The duration of adult life is about a week, rarely two weeks; the maximum number of eggs per female is about 60.

Artona is attacked by a considerable number of parasites. Several of these, like *Neoplectrus* (*Eulophidae*, 2 species), two species of *Tachinidae* and various species of *Goryphus* (*Ichneumonidae*), do not reach a high percentage of parasitism unless the host is at least fairly abundant. As our present discussion is mainly concerned with the population of Artona at a low level of density, only two species, distinguished by a highly developed "searching ability", deserve special attention here.

The most important of these is *Apanteles artonae* Rohw., a Braconid which oviposits almost exclusively in second instar larvae of Artona. The parasite larva lives internally; only one individual develops in each host. The host larva is killed in the fourth instar and the parasite then pupates in a cocoon under the remains of the caterpillar. Its period of development is 12—14 days.

*Euplectromorpha viridiceps* Ferr. is an Eulophid which oviposits on fifth instar larvae; 8—15 parasite larvae feed externally on a single Artona larva, after the latter has spun its cocoon. Pupation takes place inside the cocoon of the host. Its period of development is 18—21 days.

All parasites, when sufficiently abundant, are attacked by hyperparasites. *Apanteles*, in particular, has a wide range of enemies (at least ten species, belonging to various families of the Hymenoptera), and is never able to maintain itself in large numbers for a long time in a restricted area.

Normally Artona is a rather rare insect, but under certain conditions it becomes extremely abundant, occurring in thousands on the leaves of every coconut palm in a more or less extensive area. Such outbreaks may develop on some hundreds or thousands of trees. When the leaves of these trees have become brown, the infestation often spreads to neighbouring plantations by migration of the moths.

Serious outbreaks have occurred in most of the islands mentioned, but nowhere is the pest so injurious as in the plains of Central Java (fig. 2) where the Indonesian coconut plantations are unusually dense and extensive. In this area outbreaks are of very frequent occurrence, and sometimes many thousands of trees are defoliated as the result of a single outbreak. The most serious outbreak known started in South Djokjakarta in 1935; the infestation gradually spread over an area of 300 square km and caused the defoliation of over a million trees before it was brought under control in 1938.

When a coconut palm is defoliated (fig. 3), the nuts present at that moment are shed prematurely and no new nuts are produced during the next 1½ years.

In recent years (1938—1942) the pest has been effectively controlled in Java by spraying the leaves of the infested trees with a suspension of derrispowder in water. To apply this method successfully and economically, outbreaks must be discovered in an early stage, if possible before the trees become brown and mass migration of the moths occurs.

For this purpose, regular surveys were made of the coconut plantations in all districts, where outbreaks are known to be of common occurrence. In the course of this work, very often unusually heavy infestations of Artona, which did not develop into outbreaks, were observed. As spraying in such cases would mean a waste of time and money, it was decided to make a more detailed study of the dynamics of the Artona-population.

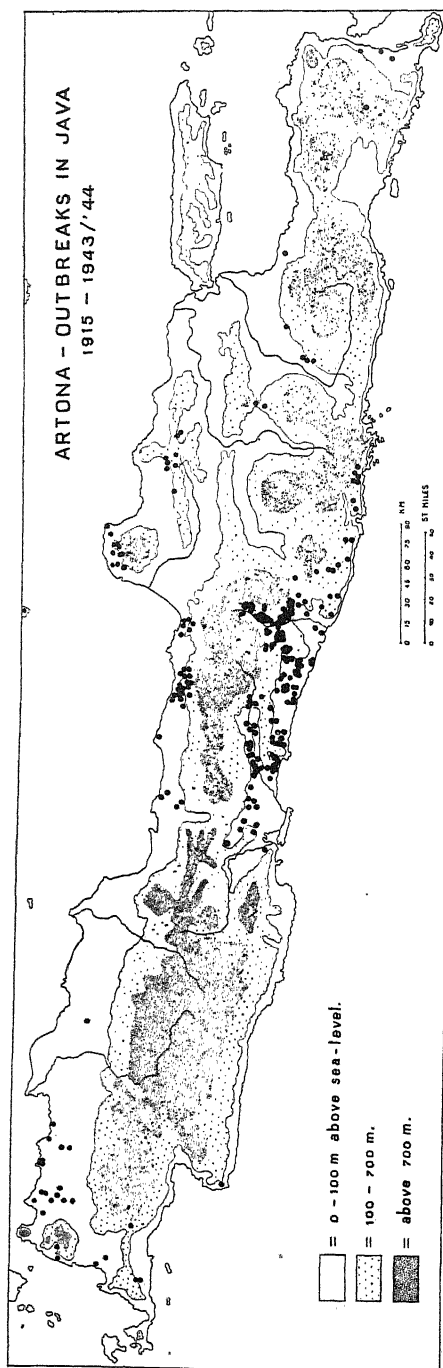


Fig. 2.



Fig. 3. Coconut palms in Indonesian village, severely damaged by the larvae of *Artona catoxantha*."

Artona has proved to be a very suitable subject for this kind of investigation. Two factors, of outstanding importance as causes of density fluctuations in many insects, viz. the temperature and the available quantity of food, are so constant throughout the year, that their influence on the dynamics of the Artona-population may be regarded as negligible. Scarcity of food occurs only when the pest has reached the outbreak-stage.

Other reasons for the suitability of Artona for this purpose are: there are about 9 generations per year, so that results may be obtained in a relatively short time; all early stages of host, parasites and hyperparasites occur on the coconut leaves, and these leaves are so uniform in size, that the number of insects per leaf may conveniently be used as a measure for expressing the population density.

Investigations have been carried out during five years on the coconut estate "Balong" (on the N. coast of Central Java) and during a longer period in the Indonesian villages in many districts in Central Java.

The Balong estate consists of two separate plots, West Balong (280 ha) and East Balong (580 ha), situated along the coast, about 700 m apart; there are 100 trees per ha. The trees were planted in the period 1914—1920; outbreaks of Artona developed five times between 1920 and 1934 in East Balong and spread from there to West Balong; they usually lasted two years and caused heavy damage (fig. 4).

Since 1936 regular tours of inspection were made here, each lasting about 5—8 weeks. Every day an area of 15—25 ha was investigated by taking samples of 8 leaves per ha-plot of 100 trees (=about 0.3 % of the leaves present). Records were made of the Artona-stages and parasites found on these leaves (fig. 5). From Dec. '39 the insect material was sent to Buitenzorg for more detailed studies.

In the Indonesian villages the surveys were made at longer intervals and the samples were generally smaller in relation to the size of the areas under observation. The figures obtained here are therefore less complete than the Balong records.

The results of the investigations at Balong are represented in figs. 6, 7 and 8.

Fig. 6 shows the distribution of Artona and its parasites at the successive times of inspection; the size of the black blocks indicates the population densities in plots of 900 trees each; the figures under these blocks represent the percentages of parasitized specimens.

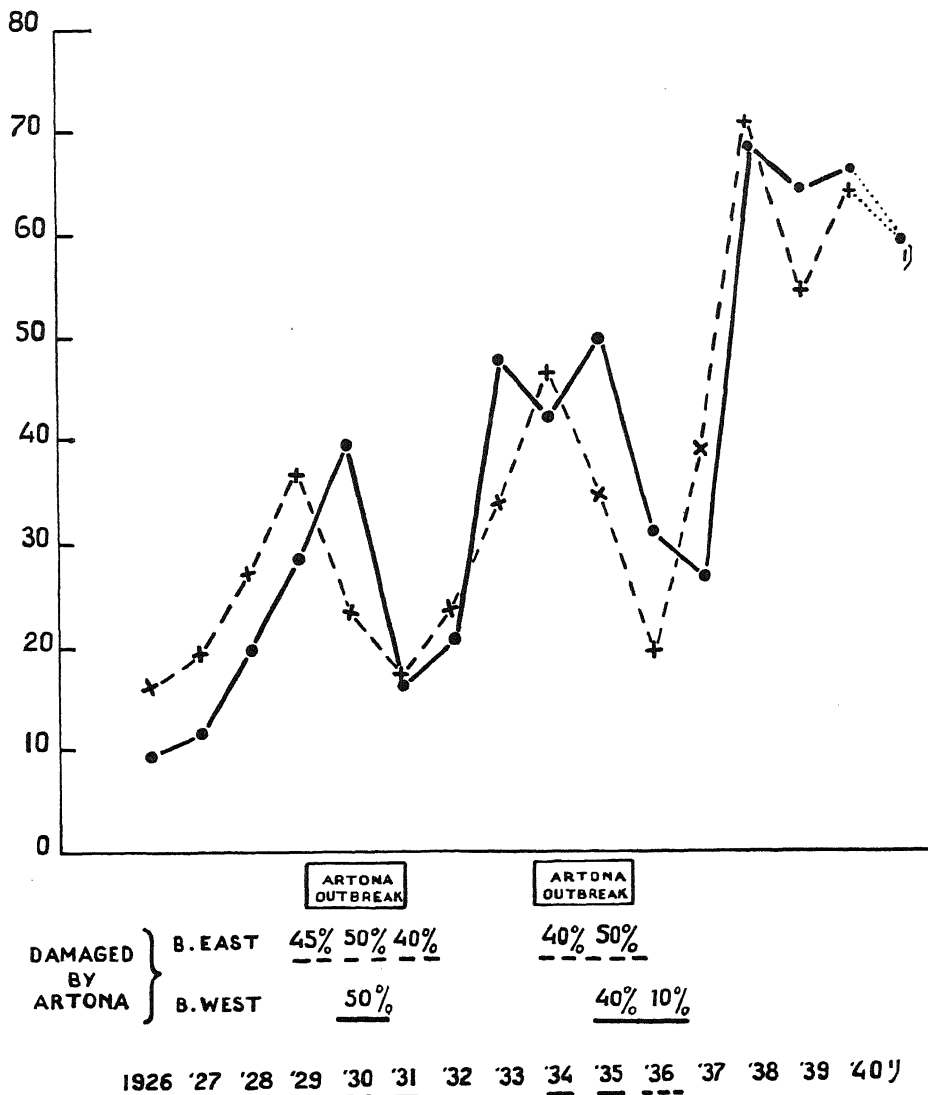
Fig. 7 gives a graphical representation of the fluctuations in the population density, both in W. and E. Balong, during five years and also shows the average and the observed rainfall per month for this period. The observed population densities are connected by curves. This appears permissible, as the number of observations is about equal to the number of Artona-generations. The observed population densities of the parasites are indicated by vertical lines, ending in a cross. These crosses are not connected, because the life cycle of the parasites is so short, that many more observations would have been needed to obtain a reliable picture of their density fluctuations.

Fig. 8 gives more detailed data on the importance of the two parasites and of the hyperparasites of *Apanteles* obtained by more exact studies of the collected insects in the laboratory.

These figures clearly demonstrate that there is a pronounced annual periodicity, very similar in both parts of the estate (fig. 7), with a regularly returning minimum density in the last months of the year. A first maximum occurs in the period March—May, a second one in Aug.—Sept., though sometimes either the first or the second maximum may be absent.

# AVERAGE PRODUCTION OF NUTS PER TREE

--+-- IN BEDJI EAST (PLANTED 1914-1920)  
 —●— IN BEDJI WEST (PLANTED 1918-1920)



J = AVERAGE FOR B.WEST + B.EAST

4. "Fig. 4. Artona-outbreaks in 1929-'31 and 1934-'36 caused heavy losses in the Balong coconut estate."



Fig. 5. Indonesian assistant examining a coconut leaf.

Extensive statistics have made it evident, that these fluctuations are mainly the result of the influence of two variable factors, rainfall and parasite-action, on the multiplication capacity of *Artona*.

The nature of the influence of the rainfall is still imperfectly known. We observe a distinct correlation between rainfall and population density: after the annual minimum there is always a marked increase in numbers, which starts shortly after the beginning of the rainy season, and on the other hand—with one exception which will be discussed later—the end of the dry season coincides with a strong reduction of the population density. We have come to the preliminary conclusion, partly based also upon the results of observations made elsewhere, that these facts can best be explained if we assume that the influence of the rainfall operates mainly indirectly. There are strong indications that periods of prolonged drought, by causing changes in the chemical composition of the coconut leaves, reduce the vitality of the insect. Field observations have shown that at the end of the dry season the egg production is generally smaller and the mortality of the early stages higher than normal, but a further study of this subject by experimental work is very desirable.

In contrast to the rainfall, the parasite action is a density dependent factor. Its influence must be considered with regard to the degree of abundance of the host, and more especially of that stage of the host, which is selected by the parasite for its oviposition.

The principal parasite at Balong is *Apanteles artonae*. To understand the relations between this species and its host, the following facts must be taken into account:



*Apanteles:*

1. The female wasp oviposits almost exclusively in second instar host larvae.
2. Its life cycle (2 weeks) is much shorter than that of the host (5—6 weeks).
3. It has a particularly well developed searching ability: it was found in the field at host densities of less than 10 per 1000 leaves, and may already exercise an appreciable degree of control at host densities of 50 to 100 per 1000 leaves.
4. When the female wasps find plenty of suitable host larvae soon after they have emerged from their cocoons, the multiplication rate of the parasite is much greater than that of the host.
5. Wherever *Apanteles* becomes numerous, its further increase is checked to a large extent by the action of hyperparasites.

*Artona:*

1. The duration of adult life is short as compared with the duration of the early stages.
2. In a population of very low density the generations overlap to such an extent, that in a limited area all stages occur simultaneously. The population is then "continuous", or in the "multiple-stage condition" (Taylor, 1937).
3. In outbreaks, the successive generations are sharply separated. Every stage is abundant for a short period (1—2 weeks) and then practically absent for a much longer period (4—5 weeks). Such a population is "discontinuous" or in the "one stage condition"<sup>1</sup>.

Considering these facts it will be evident that a continuous host population of sufficient density offers very favorable condition to *Apanteles*. In such a population the parasite rapidly increases in numbers, passing through two or three generations to one of the pest. Field observations and cage-experiments have shown that under such conditions *Apanteles* soon becomes so numerous that for some time nearly all suitable host larvae in a certain area are parasitized. Generally, however, the adult parasites do not live long enough, or their cocoons are too heavily attacked by hyps, to affect the entire host population to the same degree. The result is then that a number of host specimens of about the same age remains unparasitized: the continuous population has thus become discontinuous through the action of the parasites.

This change in composition of the host population is unfavorable to the development of both parasites occurring at Balong. Like *Apanteles*, *Euplectromorpha* has a much shorter life cycle than *Artona* and attacks only one stage of the host. It may be fairly common in a continuous host population, attacking up to 35 % of the fullgrown larvae, but increasing activity of *Apanteles* generally reduces the influence of this species.

To discuss now the interrelations between host and parasites in the course of a year (fig. 7), we take as a starting point the period of minimum density in Nov.—Dec., when an examination of 6000 leaves often did not yield a single specimen of *Artona*. From this minimum the population rapidly increases to a maximum in March—May, rarely later (1941). Initially the multiplication factor per generation is at least 15—20, but it is soon reduced by parasite action. Both parasites respond to the growth of the initially continuous host population by a rapid increase in numbers; within a few

<sup>1</sup> Taylor used this expression for a discontinuous population of *Promecotheca reichei*. In a similar population of *Artona*, an insect with a much shorter life cycle, three successive larval stages may occur simultaneously, and although generally one of these is predominant, it often happens that two stages are almost equally abundant.

## RAINFALL PER MONTH

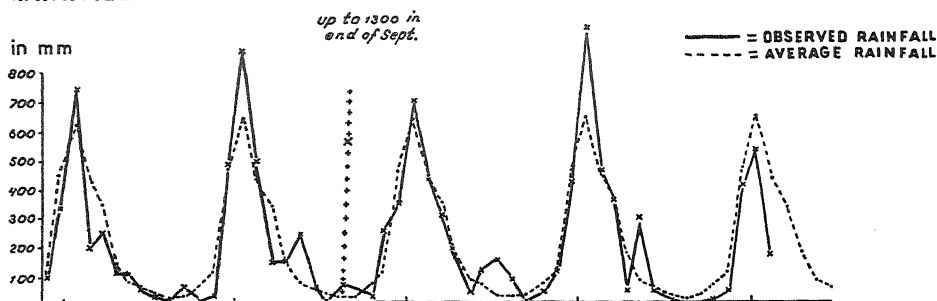
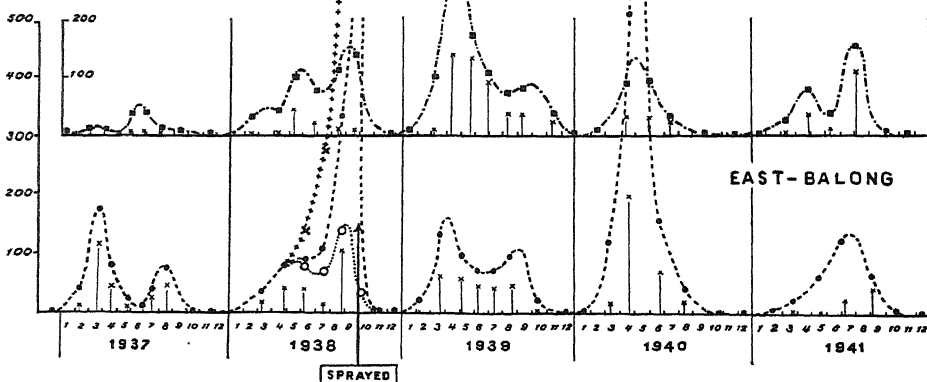
ARTONA-STAGES  
PER 1000 LEAVESRELATION BETWEEN POPULATION-DENSITY OF ARTONA AND RAINFALL ON  
BALONG-ESTATE (N. JAVA).

Fig. 7.

months they generally become so numerous, that the multiplication factor of the host is reduced to below 1. The observed percentage of parasitism at the first maximum is about 50—65; the real percentage is without doubt considerably higher.

The resultant decline of the host population, which moreover has now become distinctly discontinuous, at least locally, is unfavorable to the parasites. Their number is further reduced by the gradually increasing influence of the hyperparasites (fig. 8); it often reaches a minimum in June. This enables the host population to increase once more: in the next two generations the multiplication factor may rise again to 3—6. This second period of growth, which sometimes may be lacking, leads up to a second maximum in Aug. or Sept. Then follows another period of decline, for which, as we have seen, the influence of the parasites alone can scarcely be held responsible.

Because in the past outbreaks of Artona at Balong have occurred every 3—5 years, we may conclude that the equilibrium as outlined above is unstable and likely to be broken under certain conditions.

During the five years of observations, such a break has occurred only once, in 1938. Analysis of the data, obtained here from leaf samples, showed that in May—June

# RELATIONS BETWEEN POPULATION-DENSITY OF ARTONA, THE PARASITES APANTELES AND EUPLECTROMORPHA, AND THE HYPERPARASITES OF APANTELES (EAST-BALONG, N.JAVA).

ARTONA-STAGES  
PER 1000 LEAVES

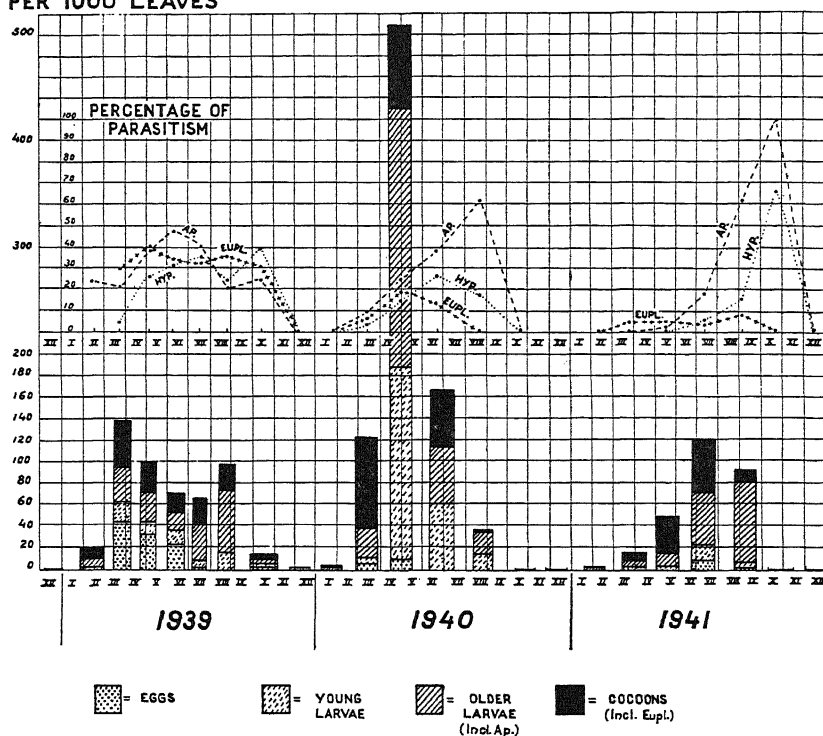


Fig. 8.

the Artona population had become discontinuous in such a way, that in a fairly large area in the Eastern part of East Balong, hence forward to be called the outbreak area, the same stage predominated at the same time. In June the average percentage of parasitism in this area was only 30, against 48 in the remainder of the estate.

A moderate infestation of 110 stages per 1000 leaves in this area in June could not be suppressed by the parasites and increased to 220 in July, while in the remainder a reduction from 83 to 73 was observed. The next generation showed, as usual, an increase everywhere, but while this was only twofold in the major part of the estate, the population in the outbreak-area went up from 220 to 960 ( $=4.4 \times$ ), with a maximum of 25 stages per leaf in some ha-plots and of an average of 10 per leaf in one 9ha plot. In the following generation, the outbreak area did not share in the general reduction: there was a rise here from 960 to 1280 ( $1.3 \times$ ), against a fall from

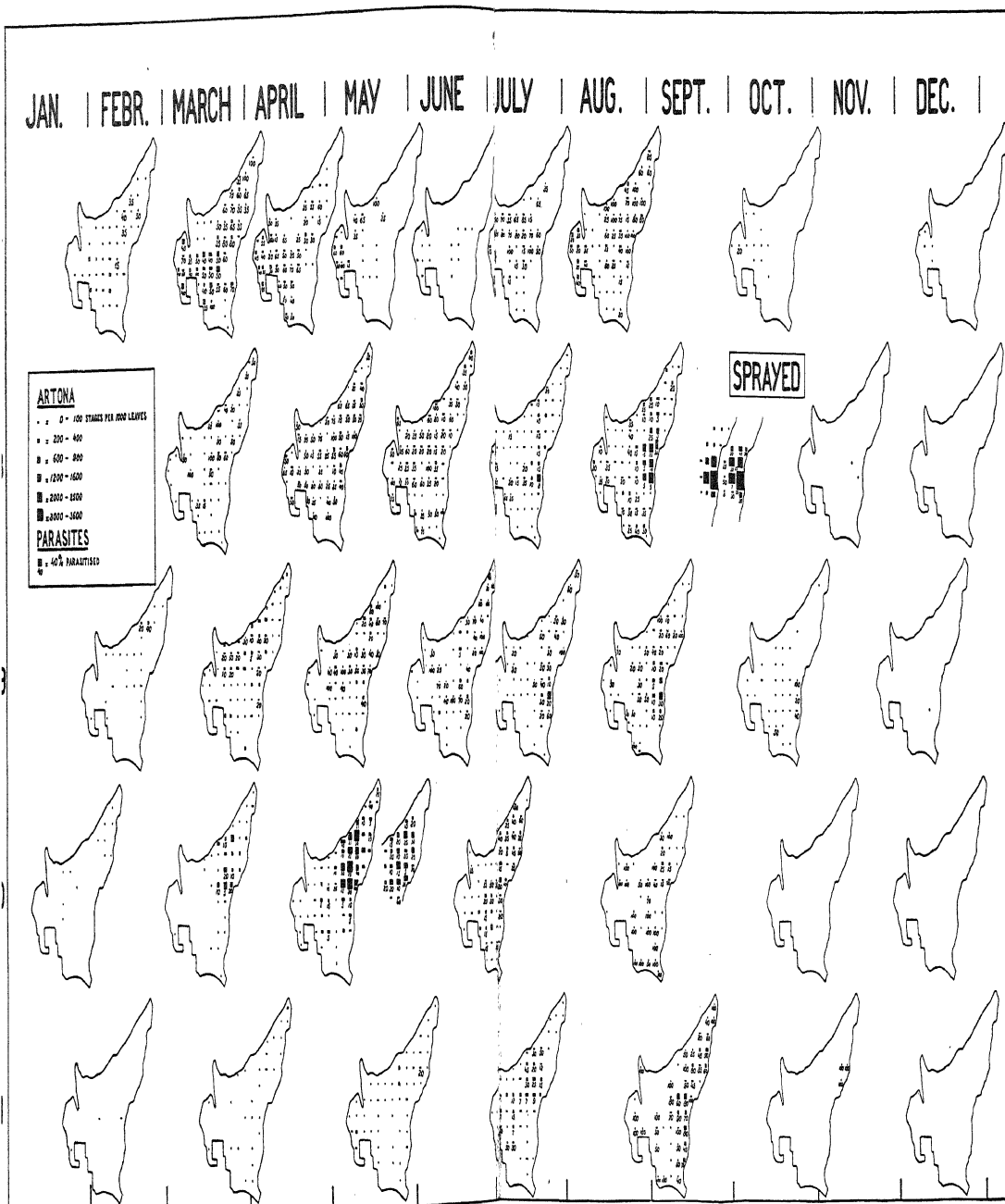


Fig. 6. Distribution of *Artona* in East Long (580 ha) during five successive years.

140 to about 40 elsewhere. An examination on 28—29 Sept. showed this population to be strongly discontinuous, more than 90 % of the stages present being young larvae. The maximum per leaf was then near 40, the highest average per 9ha-plot 15 per leaf.

As under these conditions the influence of the parasites could scarcely become important, it seemed very improbable that the population in the outbreak area would return to the usual low level before the next rainy season, when a further increase could be expected. For this reason the trees were sprayed in October. As fig. 7 shows, the results of this treatment were completely satisfactory.

The question, what would have happened if no control measures were taken, thus remains open to discussion. Judging on our experiences elsewhere, however, we regard it as practically certain, that maximum defoliation would have occurred in this area towards May or June of the next year. It is of interest to note here that in former outbreaks the first total defoliation was always observed early in the dry season. Maximum abundance of *Artona* could never have been reached at this time of the year if the insect had not been unusually abundant in the foregoing period of normal minimum density (Nov.—Dec.).

The principal results of our investigations at Balong and elsewhere may be summarized as follows:

Normally there is an unstable, but economically satisfactory, equilibrium between *Artona* and the parasites and hyperparasites associated with it. Wherever *Artona* surpasses a certain degree of abundance, the activities of the parasites (mainly *Apanteles*) tend to separate the successive generations of the host, thereby causing a condition which is detrimental to the parasites themselves (for lack of synchronisation with the host) and therefore accelerates the multiplication rate of the host. As a rule, seasonal climatic changes reduce the host population before the influence of the parasites has been eliminated, and the insect becomes so scarce at the end of the dry season, that the situation may be regarded as safe for another year.

Under certain conditions, however, the nature of which is not entirely understood, the normal equilibrium may be disturbed at an early stage of the annual fluctuation. Such disturbances occur most frequently in habitats, which are ecologically more or less isolated (small plantations, the east side of larger plantations). The successive host generations then become sharply separated, the parasites are rendered economically useless, and the host soon becomes so abundant that it is insufficiently reduced by adverse weather conditions at the end of the dry season. Consequently, when climatic conditions favor the multiplication of *Artona* again in the next rainy season, the usual increase starts from a relatively high level and this generally leads to the outbreak condition (maximum defoliation) within a few generations.

When and where outbreaks will occur is probably to a large extent a matter of chance. They are more common in some districts than in others, and sometimes develop in the same plantation at more or less regular intervals (4—9 years) without ever having been observed in neighbouring localities. This might point to the existence of differences in certain environmental conditions, the nature of which is yet unknown.

The phenomenon of the occurrence of separated generations in those tropical insects, which should normally occur in the multiple stage condition, has so far been studied in a small number of species (see Simmonds, Taylor, Schneider and Kirkpatrick). Taylor has particularly pointed out its significance in connection with problems of biological control. There is little doubt that the phenomenon is much more wide-spread and that it is of greater economic importance than has been hitherto understood.

In recent years we have observed that various insects, which are normally kept in check by natural enemies, can only occur in economically significant numbers when their populations have become discontinuous.

As regards the practical value of our population studies of *Artona*, it may be said that they have contributed much to obtain a reliable basis for predicting the further development of abnormally heavy infestations of this insect, which are discovered during the regular inspections. Such predictions are in the first instance based upon our general experience regarding the severity of outbreaks in certain districts, in connection with the extent and the density of the coconut plantations, and upon data on the density, the distribution and the nature and degree of parasitism of *Artona* in each separate infestation. We have now learned to take also into consideration for this purpose the relative abundance of the various stages of the host, the degree of ecological isolation and the expected influence of seasonal climatic changes. A study of these factors in each initial outbreak has proved of great help for deciding when and where control measures should be taken to combat the pest in the most economical way.

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## RESISTANCE IN RICE PLANT TO RICE STEM MAGGOT

By Hiroharu Yuasa

Rice stem maggot, *Chlorops oryzae* M a t s u m u r a (Chloropidae, Diptera), distributes all over Japan up from Hokkaido in the North down to Kagoshima Prefecture of Kyushu in the South. It has two generations a year in Hokkaido and Tohoku district, and probably three in the whole south western parts in Japan. The maggot feeds on graminaceous weeds during its last generation in both two and three brooded areas, and on rice plant during the first generation in two brooded area and first and second generations in three brooded area. It injures rice plant only in paddy stage in two brooded area, and both nursery and paddy stages in three brooded area, causing 10 to 20 per cent reduction of yield quite often in paddy stage.

This insect became to be important pest since about 1935. Since then, the author began the ecological study of the insect and the investigation of the damage done by it, at Tohoku Branch of our Station in Akita Prefecture where it has two generations a year. In the following he will state on resistance in rice plant to the maggot known by observations and experiments conducted.

1. Difference of percentage of injured ears among rice varieties.

Larva hatched out from egg laid on the under side of leaf in paddy field, penetrates into leaf sheath near from auricle and attains to the growth point, and feeds on young ear formed later on. Thereof, many injured grains and white empty hulls will be found in the ear after shooted and head will not hang down even at ripening stage. This ear may be called as "injured ear with scars" or simply as "injured ear".

The percentage of injured ears shows a great deviation among varieties and also by years. However, difference of percentages of injured ears is definite on the whole among varieties. That is, the percentage of injured ears of a variety represents the particular resistance of the variety. And resistance is weak in the variety of high percentage of injured ears and is strong in that of low percentage.

The varieties treated may roughly be divided into two different groups, the one resistant and the other susceptible. There was found no difference between non-glutinous and glutinous rice. But in general upland rice is more susceptible than paddy one.

2. Relation between percentage of injured ears and heading period.

It could easily be estimated that there is a relation between the percentage of injured ears and heading period of variety because the maximum emergence period of fly is rather short and larva has high necessity to feed on young ear to grow. This could be said because when the heading period is adjusted artificially the percentage of injured ears changes.

In general, it has tendency that as heading period delays the percentage of injured ears reduces (correlation coefficient—0.543). However, this is of average heading period of varieties planted in Akita Prefecture. If more early growing varieties, ear formation of which progress before larvae penetrate to injure, are used for experiment, the percentages of injured ears will become also lower as heading periods be earlier.

3. Relation between percentage of injured ears and percentage of egg deposited stems.

Usually only one egg is laid on one stem on the average. Whether more than two eggs may be laid on one stem, there will be, of course, only one injured ear. Then

many injured ears mean that eggs are laid on many stems and less ears mean that eggs are not laid on many stems. There are high correlation (correlation coefficient 0.665) between the percentage of injured ears and percentage of egg deposited stems, i.e., generally, when the percentage of egg deposited stems increases, the percentage of injured ears also increases, and *vice versa*.

The percentage of egg deposited stems has somewhat inverse correlation to the total number of stems at checking time (yearly correlation coefficients  $-0.406 \sim -0.754$ ). When the total number of stems is large, the percentage of egg deposited stems becomes small, and *vice versa*. In other words, the percentage of egg deposited stems seems to depend on the total number of stems at egg laying time, and not on selectivity of the fly in laying eggs.

On the other hand, as the numbers of stems are, in general, smaller in early varieties and are larger in late varieties, the percentages of egg deposited stems become larger in early varieties, and *vice versa*. The inverse correlation between the percentage of injured ears and heading period seems to depend on this reason.

#### 4. Relation between percentage of injured ears and mortality of young larvae.

As the larva attained near to the growth point in leaf sheath will feed on newly grown leaves one by one before it injures young ear, there will be a few small holes of about 5 mm., sometimes up to 2 cm. long, on leaf after leaf blade shoots out. And white patches of various forms will be found on several parts of leaf caused not directly by feeding but perhaps by secretion, excrements, or decayed substances of dead body of larva. Appearance of such holes and patches on leaf means that the larva has already attained to the growth point in leaf sheath. In meantime, the larva feeds on young ear and pupates. Therefore, appearance of injured ear indicates that the larva has become to maturity.

Therefore, the mortality of larvae during both prior and posterior stages, prior stage being from egg laying till the larva injures leaf and posterior stage being from the end of the prior stage till it injures young ear, will be known from the differences between percentages of egg deposited stems, of leaf injured stems and of injured ears successively. Thus there was no difference of mortality among varieties during the prior stage, but there was quite evident negative correlation (correlation coefficient  $-0.918$ ) between mortality and percentage of injured ears during the posterior stage. That is, the mortality of young larvae after their penetration into leaf sheaths is lower in the variety which shows higher percentage of injured ears, and the mortality is higher in the variety of lower percentage of injured ears. In other words, the percentage of injured ears depends on the mortality of young larvae since they injure leaves after their penetration into leaf sheaths till they injure ears.

Analysis of the mechanism and causal factors of the death of young larvae depends on further studies. However, according to the present estimations, the mechanism may perhaps relate to the feeding of larvae, and the factors concerned may be difference of food availability, lack of particular nutriment or quantitative difference of nutriment. On these points, the author can not discuss further, but it is very interesting to note that growth of larvae and growth of ears has very high correlation.

When larva dies in its young stage after penetrating into leaf sheath, ear shoot out later does not have any injured grains or white empty hulls and it seems to be healthy. But in fact, the length of the ear is short, number of rachillae decrease and consequently the total number of grains and weight of the ear decrease. Namely, according to the investigation in 1940, there were about 10 per cent reduction of total grains



in main stem ear and about 30 per cent reduction in tillers ears on variety Rikuu No. 132. Therefore, the author wishes to call this as "injured ear without scars". In general, the stem length of this injured ear is shorter than that of normal ear and the heading period delays also. Various injuries above mentioned are found in injured ears with scars as well as in those without scars. These may perhaps be caused same as in the case of white patches on leaf.

5. Difference of lethal period of larvae among rice varieties.

Growth of new healthy leaves and ears after appearance of injured leaves indicates that the larvae inside the leaf sheaths died before hand. Therefore, the period of appearance of healthy leaves (or ears) indicates the period of death of larvae. Thus the lethal period of larvae is early in resistant variety such as Ou No. 188 but is late in susceptible variety such as Rikuu No. 132. However, in exceedingly susceptible variety such as Sekiyama, only a few larvae die very early.

6. Difference of site of egg deposited leaves among rice varieties.

It seems that eggs are in general laid on lower site leaves in late varieties. This shows that egg laying period is rather simultaneous and is not varied by rice varieties.

As late varieties, in general, comparing with early varieties, have more leaves and form young ears later, the fact that eggs are laid on lower site leaves in late varieties means that it takes longer time for larvae to attain to and feed on the young ears attacking more leaves in late varieties than early varieties. This may perhaps be one of the cause of high mortality of young larvae in late varieties.

The range of egg deposited leaves is narrower in late varieties. And there is very high correlation between range of egg deposited leaves and percentage of egg deposited stems. That is, it seems that both the range of egg deposited leaves and the number of egg deposited stems depend on the same cause. This, after all, as mentioned above means that there is no selectivity of egg laying of the fly and the number of flies or number of eggs per unit area is definite. And as early varieties have less stems, percentage of egg deposited stems becomes larger and the range of egg deposited leaves becomes wider in early varieties, but these are inverse in late varieties.

7. Difference of site of injured leaves among rice varieties.

Small holes or white patches appear usually a few on the next (second), but much on the next but one (third) to egg deposited leaf. This is because the next leaf is coming out or is just before coming out about when egg is laid and is not almost attacked by newly hatched larva but usually the third and following leaves are attacked. As it takes about 5 days for one leaf to grow out and the duration of egg stage is also about 5 days, the above can easily be understood. However, in very susceptible variety such as Sekiyama, the next (second) to fourth leaves are injured much. And it should be noted that in this variety the higher site leaves rather show slightly heavier injuries. This perhaps depends on the wide range of egg deposited leaves in Sekiyama but on the other hand on particular character of this variety which may relate to its susceptibility.

On the first injured leaves there are shown usually white patches only or white patches and small holes together, but there are found small holes only in some susceptible varieties for about 20 per cent. In general, susceptible varieties have more holes but less white patches. This could be said not only on the first but also all injured leaves. According to field observations, as resistant varieties such as Ou No. 188, Ou No. 191, Sakai-kaneko, etc., grow white patched leaves especially on their tip end of leaf, field will be covered with white patched leaves in the middle to the

end of July and seems as if they were infested by diseases. However, on the contrary, as there are no white patched leaves but only holed leaves on susceptible varieties such as Sekiyama, Ryuso and most of the upland varieties, the damage is not conspicuous in the field. In short, when there are only white patches on leaves, larvae are not grown fully but larvae will grow when holed leaves appear.

#### 8. Difference of recovery among rice varieties.

Investigating the recovery of plant by comparing difference of the number and weight of ears of hills both with and without injured ears, the varieties tested show a tendency to recover, the weight of ears decreasing a little but the number of ears increasing somewhat in injured hill. However, in Rikuu No. 132, a susceptible variety, the rate of increase of the number of ears was evidently high and the weight of ears also increased. This is a very interesting point on rice plant breeding. And the fact that inspite of heavy outbreak of injured ears, this variety, Rikuu No. 132 is widely cultivated still now, depends, of course, on some of its other superior characters but also on this character of recovery which gives less influence to the total yield acting also in other aspects.

#### 9. Heredity of resistance.

Percentages of injured ears are low in varieties Ou No. 187, Ou No. 188, and Ou No. 191. One of their parents is susceptible variety Rikuu No. 132. Their resistance depends on the another parent Sakai-kaneko which is very resistant. It may be pointed out that all of these resistant varieties and other varieties that belong to resistant group are newly bred varieties. This shows that in breeding new varieties the selection of resistant varieties had been succeeded without regarding of the injury caused by rice stem maggot.

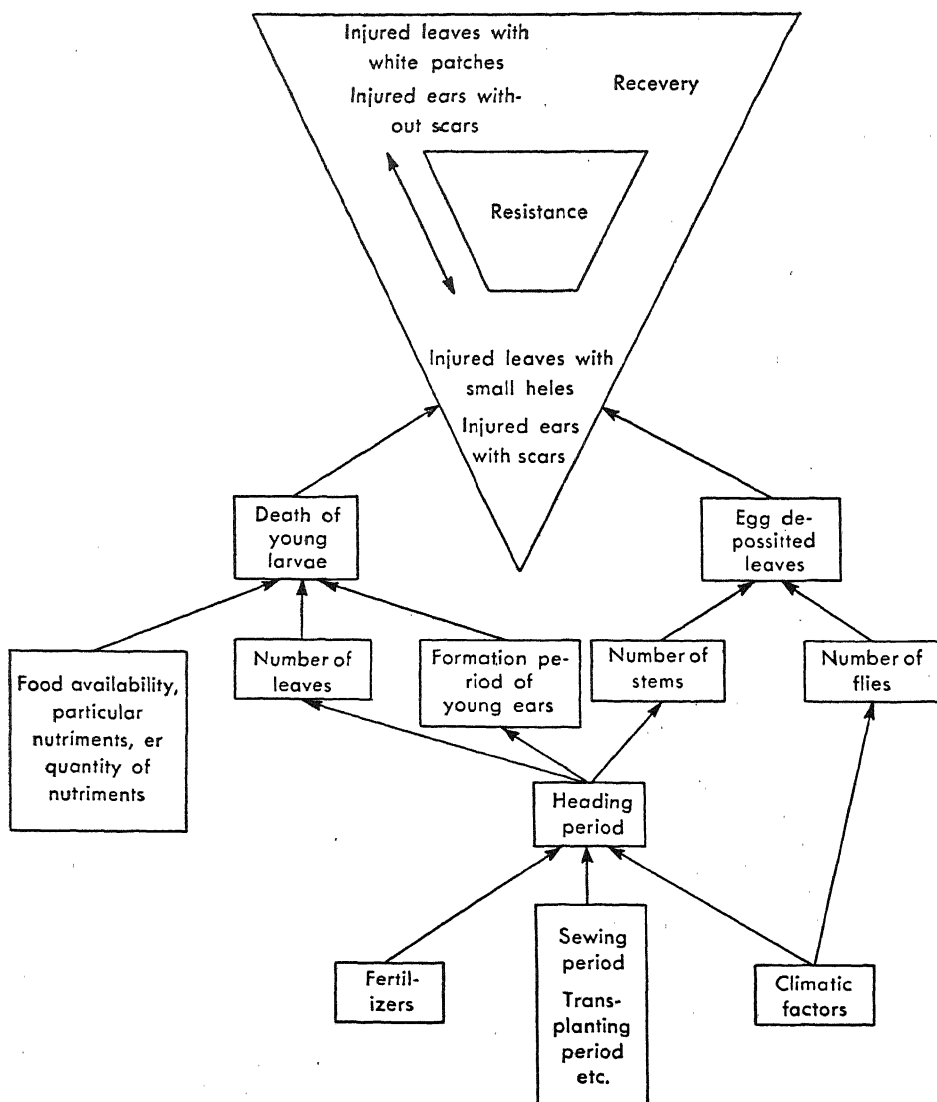
#### 10. Environmental factors influencing to resistance.

According our experimental results, the percentage of injured ears will decrease by delaying the sowing period and consequently delaying also the heading period. Experiments conducted by the Agricultural Association of Sasanami-mura, Abu-gun, Yamaguchi Prefecture, showed that the percentage of injured ears could be changed by changing the transplanting time which can adjust the heading period. It is known that the percentages of injured ears vary a lot by changing the quantity or ingredients of fertilizers. This perhaps is due to the influence of the change of fertilizers on the heading period, number of stems and death of larvae in their young stage. It is not difficult to imagine that various cultivating methods and climatic factors will affect to heading period, number of stems and death of larvae in their young stage and consequently to the percentage of injured ears. There is no question that the population density of the insect is directly related to the number of egg deposited stems, but the fact that there are no proportional relation among the yearly percentages of egg deposited stems, leaf injured stems and injured ears shows that influence of environmental factors is not small.

Thus, the percentage of injured ears of the same variety differs largely by localities. For instance, variety Kokuryo-miyako is supposed to be susceptible in Okayama and Shimane Prefectures but it is recognized as resistant in Toyama and Fukuoka Prefectures. Variety Mubo-aikoku is susceptible in Fukui and Toyama Prefectures but resistant in Gifu Prefecture. Of course as the strength of resistance differs with the year, it is still difficult to make definite conclusion. But this should be kept in mind in selecting resistant varieties.

#### 11. Conclusion.

The mechanism of resistance in rice plant to rice stem maggot is not yet fully analyzed. However, what is known or estimated up to date of the relation of factors is remarkable and interesting. It will be summarized in the following diagram.



*Diagram showing the relation of factors concerned to resistance in rice plant to rice stem maggot.*

*Leptoxyda (Dacus) longistylus* Wiedemann  
[Diptera : Trypanidae],  
A NEW PEST OF CUCURBITACEOUS PLANTS IN UPPER EGYPT

By M. S. El Zoheiry (Bey)

*Leptoxyda (Dacus) longistylus* Wiedemann (Plate I) and *D. longistylus* var. *clarus* Efflatoun, were captured by Dr. L. H. Gough, ex-director of the Entomological Section, Egypt, from Kharga Oasis on 12. 9. 1917. Prof. H. C. Efflatoun Bey had also captured *Dacus longistylus* from Asswan and Kom-Ombo, Upper Egypt, in January 1923.

Efflatoun Bey studied this species and described its var. *clarus* in his "Monograph of Egyptian Diptera", Part II, fam. *Trypanidae*, published in the Memoirs of the Royal Entomological Society of Egypt in 1924. In his Monograph, Prof. Efflatoun stated the following:—

"*Dacus longistylus* is found in Upper Egypt only, where it is very common wherever its food plant *Calotropis procera* grows. The larvae live in the fruits feeding on the seeds, and the adults run about on the leaves and fruits in the sunshine. I have captured it in Asswan and Kom-Ombo on *C. procera* only and have also bred it from larvae living in the fruits of that plant from the same localities."

Before proceeding on the Entomological aspect of the subject I must ask your permission to say a few words on the primary host plant *C. procera*.

*Calotropis procera* Ait., Fam. *Asclepiadaceae*, is called "Ushar" in Arabic, French Cotton or Mudar in English, Calotrope or Arbres à soie in French, and Wahre mudarpflanze in German. It is a shrub found in the drier parts of India, Burma and distributed to Iran and Tropical Africa. In Egypt it is wide spread in the Eastern Desert and on the sandy soils and soils of former cultivation alongside the railway lines in the Southern parts of Upper Egypt.

Goats and Sheep eat the flowers freely as well as the withered leaves, but not, as a rule, the fresh leaves. In districts where there is no good pasture cattle feed on the dry leaves. Opinion is divided as to camels browsing on this plant, some saying that they do and others that it is one plant which they will not touch.

The plant contains an acid latex which coagulates on standing, or by acetic acid and heat, resulting in a resinous mass and a clear yellowish whey-like fluid or serum. The active principle in this serum is calotropin, a powerful heart poison surpassing strophanthus and causing death by paralysis of the heart. The floss of the seeds is a sort of "vegetable silk" which can be used as a substitute for Kapok in stuffing cushions, but is inferior in buoyancy, does not stand rough usage and soon becomes waterlogged.

The stems yield a glossy flax-like fibre from the inner bast known as Ushar or Mudar fibre which is usable if properly prepared. It provides a strong cordage used for horses and cattle. Pieces of the stem are used as floats by fishermen. The floss and the bast fibre as well as the wood are all suitable for paper pulp.

The woody tissue is soft and spongy and furnishes a good charcoal. The economic importance of this plant in the Southern part of Upper Egypt is that it is collected from the desert, dried and used for fuel. *Calotropis procera* was the only host plant of *Leptoxyda longistylus* since its appearance in 1917. The insect was not recorded as a pest of any cultivated crop up to 1947.

## PLATE 1

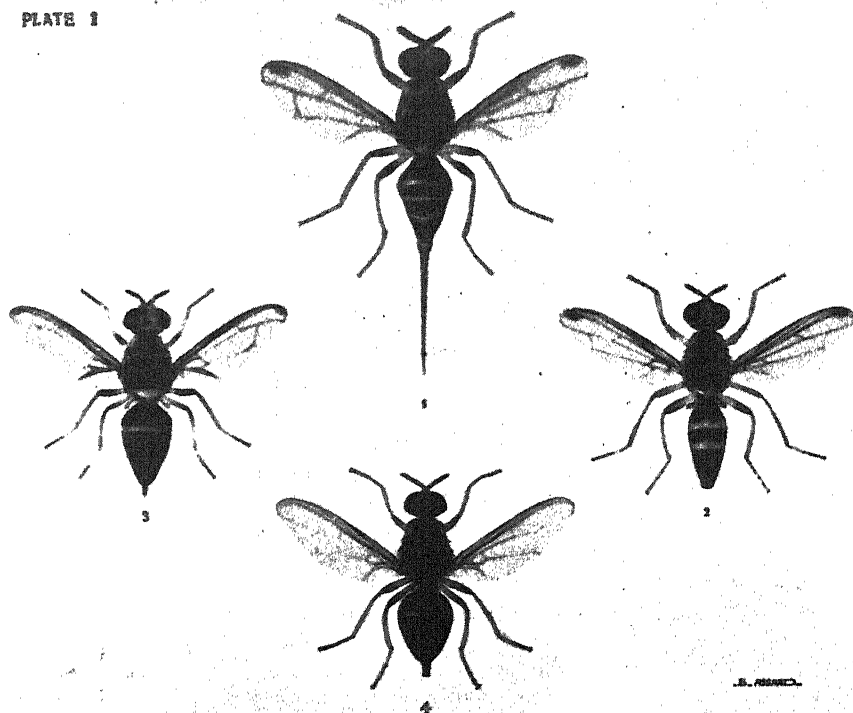


Fig. 1. *Leptoxyda longistylus* Wied. var. *clarus* Efflatoun. ♀ Bred from *Calotropis procera*.

Fig. 2. Ditto, ♂.

Fig. 3. *Leptoxyda longistylus* Wied., ♂. Bred from snake cucumber.

Fig. 4. Ditto, ♀. Bred from water-melon.

But in June 1947 it was found attacking the fruits of four cucurbitaceous plants viz:

(1) The hairy cucumber (*Cucumis melo* var. *chate* Naud.), (2) Cucumber (*C. sativus* L.), (3) Snake cucumber (*C. sativus* L. var. *flexuosus* Naud.), (4) Water-melon (*Citrullus vulgaris* Schard.)

These plants are cultivated in large areas on the lands bordering the Nile and on the river islands in Asswan Province, Upper Egypt. *Calotropis* grows wild amongst these plants and was found together with these plants heavily infested with *Leptoxyda longistylus*. Inspections of all cucumber and water-melon plantations in Upper Egypt, made in October 1947 and in April 1948 have shown that all provinces north of Asswan were free from the pest with the exception of Minia Province, 500 kilometers north of Asswan, where the cucumbers cultivated on the Experimental Farm of the Minia intermediate school of Agriculture were found attacked by *Leptoxyda longistylus*.

The main host plant, *Calotropis*, was the source of infestation of the cucurbits cultivated in Asswan; its fruits were heavily infested with larvae feeding on and damaging the seeds; many pupae were found on the decaying silky floss and on the outside of the fruit valves (Figs. 2 & 3). But in the other infested zone there

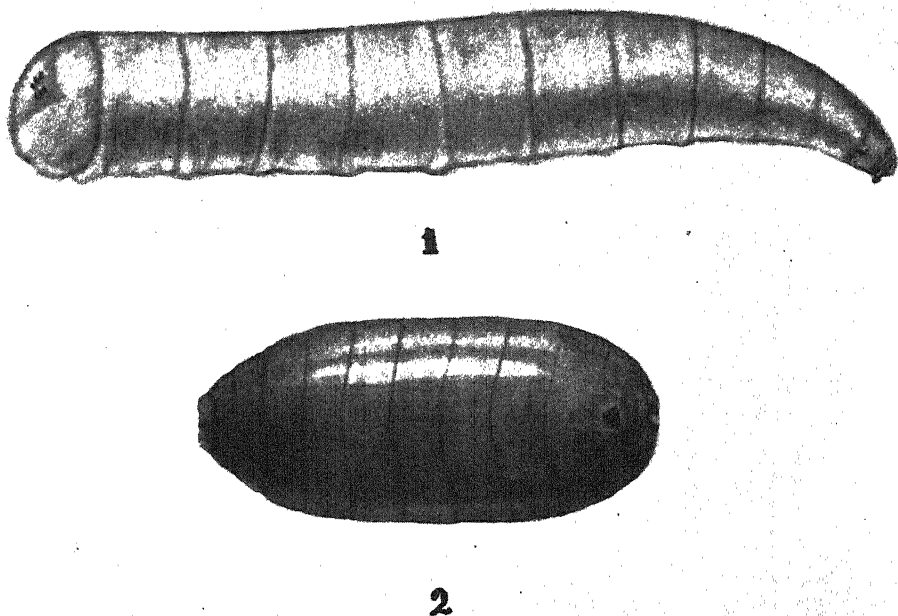


Fig. 1. Full grown maggot of *Leptoxya longistylus* Wied.

Fig. 2. Pupa.

were no *Calotropis* plants growing in the cucumber fields nor were any in the Desert area lying East of Minia Province. The fly had therefore adapted itself to live directly on the cucurbits and in the absence of its primary host plant, *Calotropis procera*.

#### Symptoms

The symptoms of attack are:

- (A) On *Calotropis procera* (Figs. 4, 5, 6, 7 and 8):
  - (1) Presence of larvae and pupae in the seed floss and on the fruit valves.
  - (2) Darkening and wrinkling of the fruit valves.
  - (3) Decay of the white silky floss which turns into a brown compact mass.
  - (4) Destruction of the seed.
- (B) On cucurbitaceous fruits (Figs. 9, 10, 11 and 12):
  - (1) Yellowing and withering of the fruits.
  - (2) Presence of several punctures covered with a dry yellowish secretion on the rind of the fruits.
  - (3) Presence of the maggots within the pulp.
  - (4) Rotting of pulp and seed.
  - (5) Splitting of heavily infested fruits.

## PLATE III

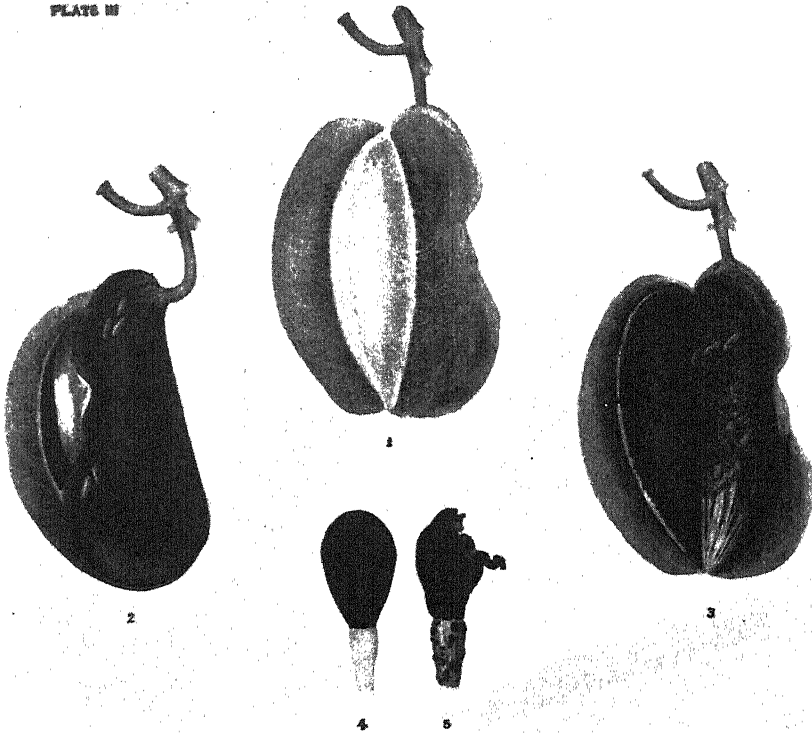


Fig. 1. Sound fruit of *Calopterus procera*.

Fig. 2. Fruit of *Calopterus procera* showing pupae of *Leptoxyla longistylus* on fruit valve.

Fig. 3. Fruit of *Calopterus procera* opened to show pupae and work of maggots in the damaged silk floss.

Fig. 4. (A.) Sound seed of *Calopterus procera* ( $\times 5$ ). (B.) Damaged seed of *Calopterus procera* showing digging holes, rotting and frass of maggots.

### Life-History

The flies appear in late Autumn and are seen walking on the leaves of *Calotropis* in sunshine. The female has a very long cylindrical tapering ovipositor, by which it punctures the fruit and will lay about 200 eggs during a period of a month placing but one in each puncture just under the skin, so that a single fly may do considerable damage. The egg hatches in a few days into a small white maggot, which burrows inside the fruit and then feeds upon the pulp and seeds. The maggot becomes full grown in about two weeks. In *calotropis*, pupation takes place in the fruits but the larvae living in the succulent fruits of cucurbits leave their host and pupate in the ground. Pupation period varies from 12 to 17 days in Spring and from 8 to 10 days in early summer. The number of generations is not yet definitely known. I was able to breed four generations during the period from March till July 1948.

## PLATE IV

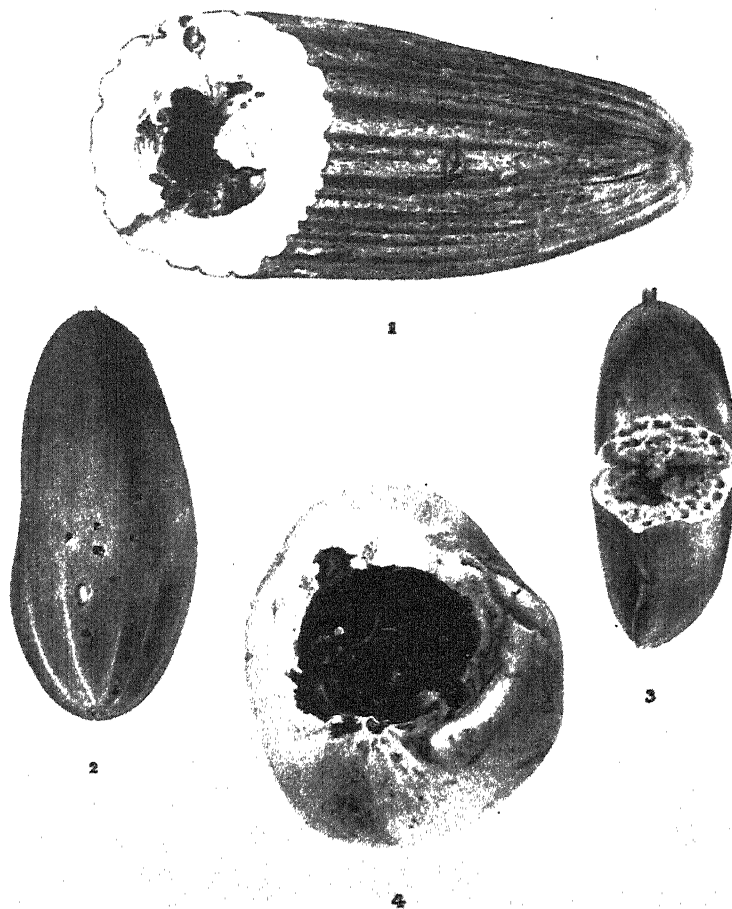


Fig. 1. Cross Section in snake cucumber showing damage of pulp and seed by the maggots of *Leptoxyda longistylus*.

Fig. 2. Cucumber fruit punctured in 10 places by female *Leptoxyda longistylus*.

Fig. 3. Cucumber fruit showing yellowing and damage of pulp and seed by maggots of *Leptoxyda longistylus*.

Fig. 4. Young water-melon fruit showing complete rotting of pulp and seed by maggots of *Leptoxyda longistylus*.



*Control*

- (a) The transportation of cucurbitaceous plants and fruits from infested to free zones by road, river, railways or air and the selling of infested fruits were prohibited by an arrette issued in August 1947.
- (b) Plants of *calotropis procera* growing in the cultivated area of the infested zone were uprooted and burnt.
- (c) Attacked fruits of cucurbits were collected and burnt.
- (d) A spray composed of:—
  - 1 oz. Sodium fluosilicate,
  - 2 lbs. granulated sugar,
  - 4 gals. of waterwas applied in droplets on the leaves of the plants three times at intervals of 15 days to attract the flies and kill them before oviposition.
- (e) A bait composed of wheat bran, molasses and sodium arsenite placed in handful heaps under plants and in shaded situations in the field had also given satisfactory results in killing adult flies before laying their eggs, provided that the bait is kept moist by addition of the sweetened solution as soon as the bait becomes dry.

I have to thank M. Z a k i, Senior Entomologist and M. A s e m, technical assistant for their Sincere cooperation in the study of this new insect pest.

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THE WASP BEETLE, *Chlorophorus varius* Mull.,  
[Coleoptera — Cerambycidae],  
A NEW PEST OF GRAPE VINES IN EGYPT

By M. S. El Zoheiry (Bey)

The wasp beetle, *Chlorophorus varius* Mull. (*Clytanthus varius* F.) had been known in Egypt before 1913 as a pest of secondary importance in peach, apricot, apple, robinia and mulberry. The larvae of this longicorn beetle eat out galleries in the solid wood of the branches and occasionally may be found in the trunk. The beetles may frequently be captured on the white umbels (inflorescences) of the Bishop's weed (*Ammi* spp.).

It was not recorded or found in grape vines between 1913 and 1945. But, in February 1946, cerambycid larvae were found in 3-year old trunks and in two-year-old branches of the sultanina and Italia grape vines growing in one of the big grape-vine plantations in Lower Egypt.

The Entomological Section started at once the study of this new grape-vine pest.

The larvae were left to breed within infested canes in the laboratory and the emerging beetles were found to be *Chlorophorus varius* Mull.

This beetle (Fig. 1.) is a slenderly built insect 9—13 millimetres long by 3—5 millimetres across the wing covers; black marked with bright mustard yellow markings and in its bright yellow and black livery calls to mind the warning colouration of the wasp—hence its popular name; it has reddish legs and antennae. Although a

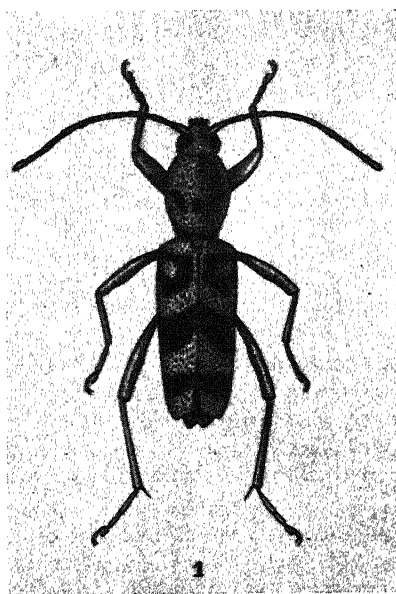


Fig. 1.

longicorn the antennae are shorter than the body. There are three black bands on the prothorax which are separated from each other in *Chlorophorus varius* Mull., and are coalescing and forming one black band, nearly crescent in shape, in its var. *damascenus* Chevr. (Fig. 2.)

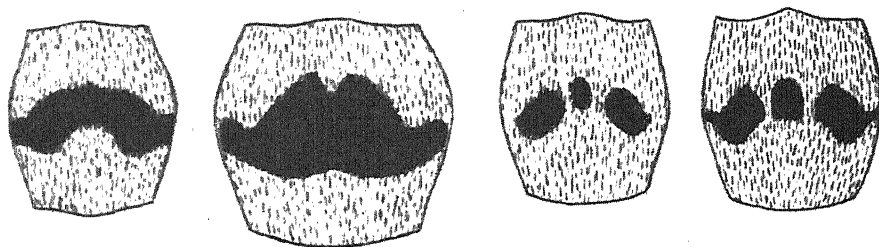


Fig. 2.

#### *Distribution and host varieties*

A survey of all grape-vine plantations, made in 1946 and 1947, has shown that the pest had established itself in many widely separated plantations in Lower Egypt, attacking certain varieties of imported grape vines, viz. Sultanina (Sultana of Australia, Tompson of California), Italia, Muskat, Roumi, Gharibi and Ginaclis; the Sultanina and the Italia were the most susceptible.

The insect was also found attacking old sesban (*Sesbania aculeata* Poir. and *S. aegyptiaca* Buch-Hem.) grown as hedges in few grape-vine orchards or used as wooden supports of vine-trees.

#### *Life History*

Grape-vine canes containing larvae were collected in February 1946 and were placed in breeding boxes under laboratory conditions. Few larvae deserted the canes and died but the majority remained in their tunnels and completed their larval stage. Pupation started in the second half of April and was continued, according to larval age, until the end of April. The beetles began to emerge from the 5th to the 25th of May.

Under field conditions adults were first captured on the 25th April and continued to emerge until July.

The adults, bred in the laboratory, were separated in pairs on the first day of emergence and were fed on flowers. Copulation started one day after emergence and continued for from 2 to 5 days, being repeated five to eight times a day. Each process lasted from 20 to 90 minutes. The longevity of the adult females was 13 to 15 days and the males 15 days. Starved adults were able to live for eight and half days.

Oviposition started three to six days after the last copulation process. The eggs are laid singly by the long ovipositor in the crevices of the bark, under the bark and in wounds on the canes. The egg (Fig. 3) is small, 1 mm. in length and 0.3 mm. broad; elongated, and creamy white in colour. The eggs hatch in seven to ten days. We failed to breed the newly hatched larvae under laboratory conditions; they died

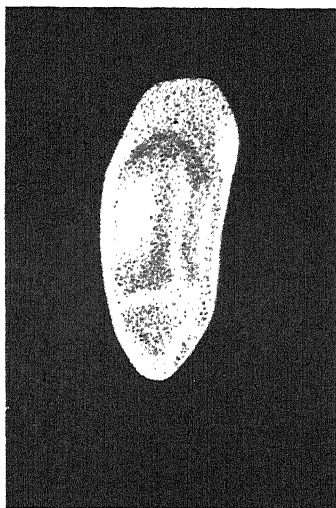


Fig. 3.

young. The full grown larva (Fig. 4) is dull white or sometimes creamy in colour; it measures about two centimetres in length; the body is cylindrical and round-headed.

The larvae pupate at the end of the gallery just beneath the bark, it is cream coloured and has the form of the future beetle.

#### *Symptoms and Nature of Damage*

As mentioned before, the larvae eat out galleries in the branches and in the trunk just beneath the bark (Fig. 5), but, when they work their way through the tips of pruned canes, they tunnel through the pith and gradually hollow it out. They leave a large amount of frass behind them and later they make a cell by building up a barrier of frass in which they transform to pupae and adults. The work of the larva beneath the bark loosens it and allows moisture and mold to reach the solid wood which is seen, after scraping the bark, to be yellowish white in colour as distinguished from the usual brownish colour of sound grape-vine wood. The infested parts of the grape canes and stems die and their bark peels readily. The frass will be found under the bark of the attacked portions. In severe cases of attack the frass could be seen on the ground and the larvae or pupae could be found embedded in their frass cells.

Attacked bases of pruned canes are seen dry, with split bark and are yellowish white in colour. They are killed by the larvae which tunnel through them and work downwards into the stems for a length of 5 to 10 cms. Round exit holes of the emerging beetles are seen on the stems and canes. Infested canes are killed and heavy infestations in the stem cause the death of the tree.

#### *Control*

Experiments were carried out by injection of carbon bisulphide, benzine or orthodichlorobenzine into the wood of infested canes and stems by using a syringe (Fig. 6) fitted with a steel needle during the dormant period of the trees. Results of these expe-

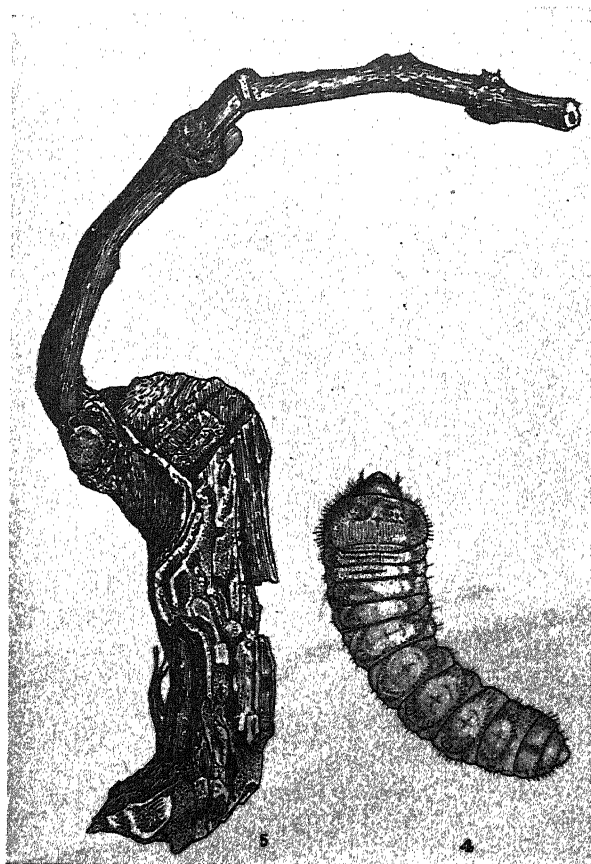


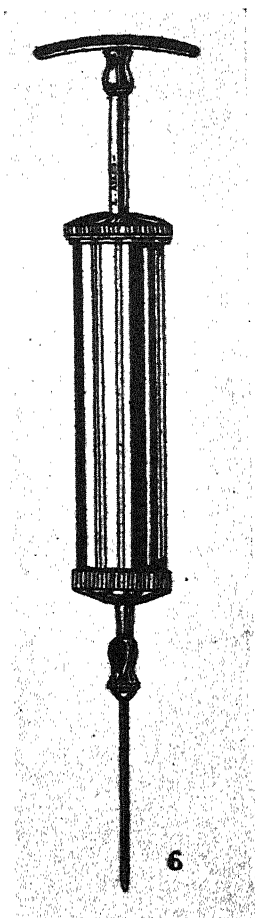
Fig. 4—5.

periments have shown that carbon bisulphide injections were harmless to the trees and killed 100 % of the larvae inside the wood. Soaking of infested parts with the same material followed immediately by coating the part soaked with  $\text{CS}_2$  with a layer of moist earth killed all the larvae just under the bark. From 1 to 10 cm<sup>3</sup> were sufficient for treating an infested cane.

$\text{CS}_2$  was not tested during the growing period.

Benzine was equally effective and was easily applicable in treating infested bases of pruned canes. It was also harmless to the trees even when used during growing period. Orthodichlorobenzine gave only 75 % kill of larvae located just under the bark. Larvae burrowing inside the wood or embedded in the frass were found alive.

The larvae were killed in 24 hours by injection with  $\text{CS}_2$  or benzine. Direct contact with either of these chemicals by the process of soaking killed the larvae in 4 hours. 1400 acres of grape-vine were successfully treated with  $\text{CS}_2$  and benzine in 1946/1947 and 1948.



*Fig. 6.*

I must mention and thank my assistant A. M. Kamel for carrying out field observations and for the execution and supervision of the campaign of controlling this pest.

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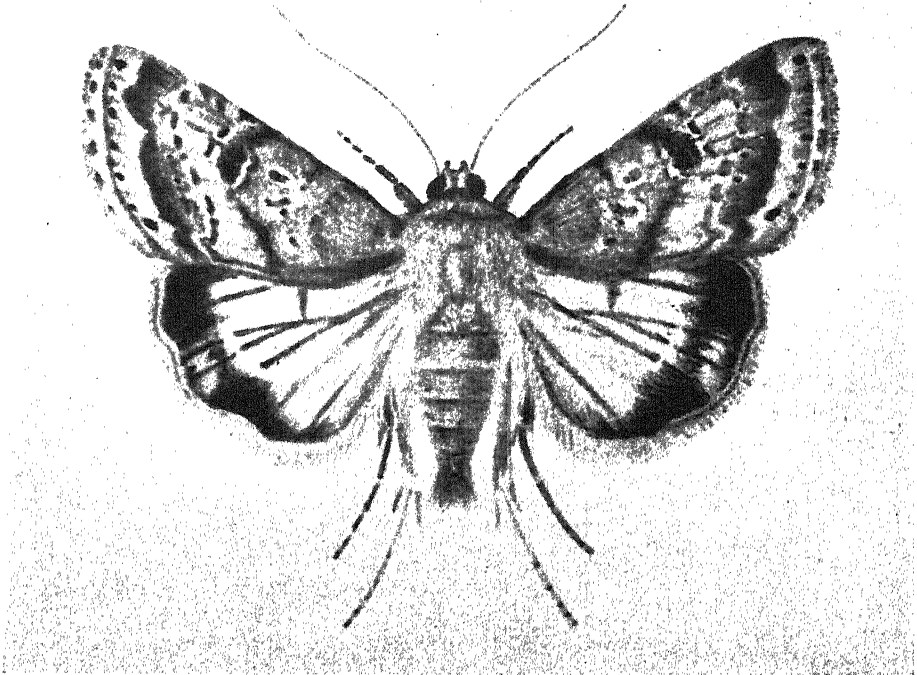
*Heliothis nubigera* H.-S.  
[Lepidoptera — Noctuidae],  
A NEW PEST OF WATER-MELONS IN EGYPT

By *M. S. El Zobeiry (Bey)*

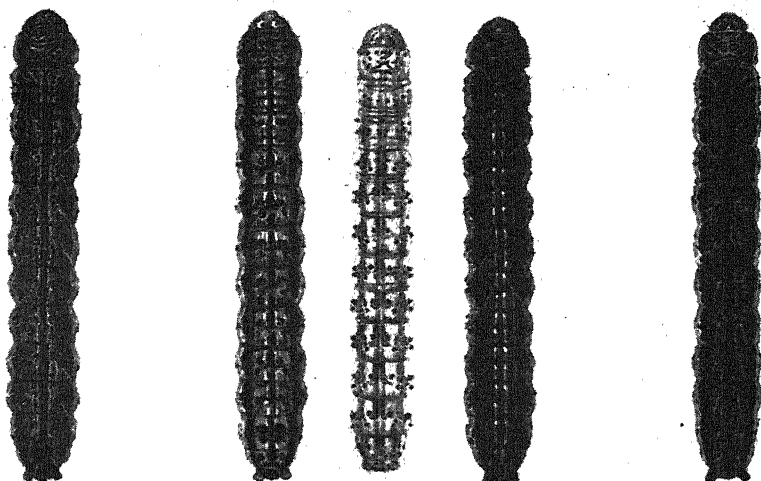
Three species of the genus *Heliothis* (*Chloridea*) are recorded in Egypt, viz. *Heliothis* (*Chloridea*) *obsoleta* F., *H. peltigera* Schiff., and *H. nubigera* H.-S.

The first species, known in the U.S.A. as the cotton bollworm, corn ear worm, tomato fruit worm, and false budworm of tobacco, according to the various crops it attacks, is known to be a very general feeder, attacking also many wild plants, garden vegetables, alfalfa and cowpeas. The loss attributed to the Corn Ear Worm in the United States is valued at no less than 20 millions of pounds sterling—distributed over the cotton, corn, and tomato growing industries.

In Egypt *C. obsoleta* does not seem to be a particularly common insect. It has been bred from caterpillars found amongst wheat plants. It is rare on and quite without importance as regards this food plant. It may be found in cotton bolls in Egypt but it is not at all common on cotton. Careful and long search in a field of maize



*Fig. 1.*



2

will reveal a cob here and there which harbours one of *C. obsoleta* larvae which will often bore down through the tassel to get at the soft grains. The larvae have been found feeding on unripe millet grain. Several caterpillars may be present in an infested head of grain to which they may do appreciable harm, not only by actually eating the green grain but also by soiling the untouched parts with accumulations of excrement, which encourages the growth of moulds.

I quote the following from F. C. Willcocks:

"Why *C. obsoleta* is a so much more serious pest in the U.S.A. than it appears to be in other parts of its range is not, I believe, definitely known. Considering the favourable climatic and physical features of the country as well as the favourable cropping, one might well think that conditions of Egypt would be particularly favourable for the annual multiplication of the same insect to a pest level. Fortunately this is not the case, so much so that we doubt if its presence is ever noted by anyone but entomologists on the look out for it. What holds its population here at so stable and apparently so low a level is not known. Presumably, it may be a question of efficient control by parasites; it seems unlikely that there can be any particular relation between irrigation and the rather peculiar mode of pupation practised by this boll-worm."

The questionnaire statement of F. C. Willcocks will find the reply in the following incidents concerning the closely related species *H. nubigera* H.-S.

*Heliothis nubigera* Fabr., was recorded from Kharga Oasis and Meadi, two localities surrounded by desert areas.

On the 24th, April, this year (1948), the speaker visited the District of Salhieh, which lies on the border of the cultivated zone and the edge of the desert region which



extends to the Suez canal. This district is one of the important centres of water-melon cultivation in Egypt. Water-melons are cultivated there in trenches cut down deep in the sandy areas on the system of dry cultivation. The desert area surrounding the water-melon cultivations becomes profuse with desert plants in years of heavy winter rains.



3

An inspection of the young water-melons revealed the presence of larvae of *Heliothis nubigera* feeding on the leaves in abundant numbers. Examination of the wild plants growing on the desert sandy soil surrounding the water-melon cultivations showed that these larvae were voraciously feeding on five species of desert plants viz:—

*Zygophyllum coccineum* (Fam. *Zygophyllaceae*),

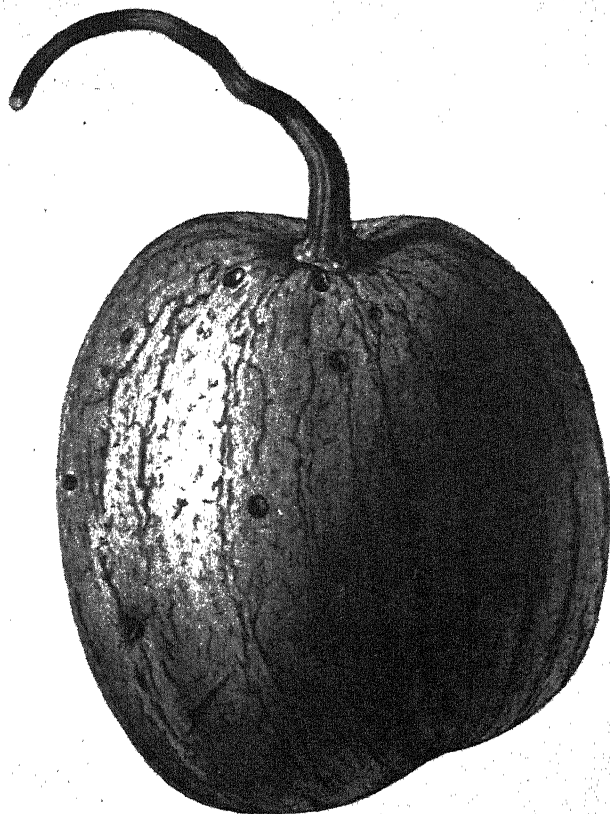
*Chenopodium album* (Fam. *Chenopodiaceae*),

*Echinops spinosus* (Fam. *Compositae*),

*Panicum turgidum* (Fam. *Gramineae*), and

*Zilla spinosa* (Fam. *Cruciferae*).

During daytime the larvae avoid the heat of the sand and climb these plants feeding on their succulent leaves. At night they march in big masses towards the water-melon plantations. They attack the leaves and the young fruits (Fig. 4).



*Fig. 4.*

The full grown larvae (Plate I) are about 4 cms long, very robust and marked with beautiful conspicuous stripes. The colouration varies greatly, cream, pink, green, brown, slate or black. The body is marked in some larvae with prominent stripes of varying concordant shades and the majority have stripes and dots of two or three colours. The larval stage is 16—18 days in Summer.

Pupation takes place in the ground. The full grown larva burrows into sandy soil and forms a cell in which it transforms into a pupa, mahogany-brown in colour (Fig. 3). The pupal stage is about 10—11 days. The whole life cycle takes about 5 weeks.

The second generation appeared in May, 1948. The larvae were full grown on the 30th. The predominant colouration of the larvae was yellow, various colours were also present. A third generation was expected in July but it did not appear neither on the water-melons nor on the desert vegetation which begins to dry up under conditions of dryness and Summer heat.

Information collected from the farmers agreed in that this pest appears in years of heavy winter rains and that there was a similar invasion in 1945 when a rain storm flooded this desert area.

To turn back to Willcock's statement, it is quite clear that the mode of pupation practised by this pest i.e. pupation in the sandy soils which become very hot in the summer and the dependence of the insect on desert plants as primary hosts which may or may not become green or remain green for a long period according to rain falls are the factors which play an important role in the natural control of this pest. The pupae are killed by the excessive heat of the sand during hot summer days and the moths that might emerge from cooler places find no suitable hosts for the completion of the life cycle of the successive generations.

#### *Control*

The habit of marching of the larvae from the desert area to the water-melon plantations was made use of in trapping the larvae in dry trenches dug 20 metres from and around the plantations. The larvae fell into these trenches and were unable to crawl up the opposite vertical side of the trench. They remained there overnight and took shelter in the shaded parts of the trench during daytime. They were collected by the farmers and burnt.

A belt of the desert weeds surrounding the water-melon plantations was dusted with arsenical lime sulphur in the early morning and the larvae which were feeding on these plants were found completely dead. Investigations to clear up the life history, habits and ecological factors affecting the life of this pest are in progress.

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## RATOON COTTON AS A TRAP CROP FOR THE PINK BOLLWORM, *Platyedra gossypiella* Saund.

By M. S. El Zoheiry (Bey)

Ratoon cotton is cotton plants left in the ground for two or more years after pruning of the old growth in Winter. With an old well formed root system, ratoon cotton starts flowering one month earlier than normal annual cotton and gives its crop some forty days earlier. Thus, Ratoon cotton escapes, to a great deal, the late summer serious bollworm attack which reaches 100 % of the late formed green bolls on annual cotton plants.

The system of ratooning cotton was fairly common in the northern parts of Lower Egypt where annual cotton gave poor yield due to late sowing and late maturing followed by heavy pink bollworm attacks.

The disadvantages of ratoon cotton are its bad effects on the adjacent annual cotton; bollworm moths normally appear in the fields long before the formation of green bolls or even flower buds on annual cotton plants; in the absence of ratoon cotton, the early emerging moths die in April and early May without producing offspring because of lack of larval food: flower buds and flowers. But in its presence, the formation of the buds, flowers and bolls of ratoon cotton, a month or six weeks earlier than the annual cotton, gives the early emerging moths a valuable help at a very critical period by sustaining first generation larvae of the Pink Bollworm and thus carries over the infestation to annual cotton—it becomes a focus of bollworm infestations.

Experiments carried out in several parts of the country have definitely proved that annual cotton in close proximity to ratoon cotton suffered very badly from bollworm damage, losing more than fifty per cent of the crop. When ratoon was removed the attack dropped to its normal light or medium degree.

For these reasons, ratooning of cotton was prohibited in the whole country to check the multiplication of the Pink Bollworm, *Platyedra gossypiella* Saund., and the Egyptian Spiky Bollworm, *Earias insulana* Bois.

This was the status of ratoon cotton and Bollworms from 1912 till 1940 when the Entomological Section adopted the idea of utilising small areas of ratoon cotton to attract the early bollworm moths to lay their eggs on its flower buds and bolls. None of the several host plants of the Pink Bollworm is more attractive or even equally attractive to this insect than cotton itself.

The success of the idea of trapping the first generation larvae of the Pink Bollworm is dependent on the collection and destruction of the infested flower buds and bolls of ratoon cotton before the formation of the flower buds and bolls of the annual crop, which starts in June.

Practical tests of the system were made by Ibrahim Bishara, Chief, Cotton Pests Research Sub-Section, on the farms of the Ministry of Agriculture. Two farms were chosen in 1942, the first at Gemmaiza, in the centre of the Delta, and the second at Sakha, in the North Delta region. About 16 acres at Sakha and 2 acres at Gemmaiza of the 1941 annual cotton were left standing, up till January 1942, when they were pruned to the height of about 30 cms above ground level.

The plots for ratooning (each about  $\frac{1}{4}$  of an acre) were chosen on different parts of the farm, to ensure maximum attraction of the moths. They were weeded and watered as usual from March onwards. After flowering and formation of bolls all flower buds, flowers and bolls were removed and destroyed, and the ratoon plants were uprooted in June. Samples of buds and flowers were examined for bollworm infestation, with the following results:—

In 620 plants bearing about 3360 flower buds, flowers and bolls there were 860 bollworms as shown in the following table:

Locality	Date of removal of plants 1942	Number plants examined	Material found on the plants examined			Larvae found	
			small green bolls	flowers	flower buds	Pink boll worms	<u>Earias</u>
Gemmaiza	May 21	320	49	32	1092	421	3
Sakha	May 31	300	21	110	2155	435	1
Total		620	70	142	3247	856	4

The percentage of small larvae to total larvae in the above examination was 90 at Gemmaiza and 88 at Sakha.

At this rate the removal of one acre of ratoon towards the end of May would mean the destruction of about 40,000 to 80,000 larvae. If these, or a large number of them, were left to breed on annual cotton as usual, they would constitute a big proportion of the total general infestation. Ratoon cotton, utilised in this way, is a successful trap crop for early bollworm moths; but it must be uprooted in the proper time. A delay of only one week would change the situation from good to bad.

In the following year, 1943, the experiment was repeated at Sakha and Gemmaiza as well as on the experimental farm of the Botanical Section at Giza, close to Cairo. To increase the efficiency of ratoon cotton as a trap crop, the fresh flowers were removed daily during late April, May and June in place of removal of buds and flowers once & for all before the end of May. By this means a far bigger number of larvae could be destroyed, without giving any larvae the chance of pupation. The general bollworm infestation on annual cotton on these farms showed a noticeable reduction.

The method was not advocated for general use for fear of neglect of small farmers in removing the ratoon in the proper time, in which case it would be decidedly harmful instead of beneficial. On Government farms and on big estates where proper care could be taken this method should be successful.

## SECTION VI

## LES KERMES (Hom. Coccoidea) DES CHENES EN EUROPE ET DANS LE BASSIN MÉDITERRANÉEN

Par A. Balachowsky

Le genre *Kermes* Boitard 1828<sup>1</sup> qui comprend de nombreuses espèces répandues dans l'hémisphère nord du globe forme à lui seul la tribu des *Kermesini*<sup>2</sup> dans la vaste famille des *Lecanoidae*<sup>3</sup>.

La tribu des *Kermesini* est très voisine de celle des *Eriococcini* (comprenant les g. *Eriococcus* Targ., *Gossyparia* Sign., *Nidularia* Targ., *Cryptococcus* Dougl. etc. . . .) faisant également partie de la fam. des *Lecanoidae* sub. fam. des *Kermesinae*. Les affinités entre ces deux groupements ressortent tant par l'étude des formes adultes, que par celle des larves, et elles ont été mises en évidence par de nombreux auteurs notamment Green (1928), Ferris (1937), Goux (1946) et nous-même (1942; 1948).

Presque tous les *Kermes* vivent sur les *Quercus* à feuilles caduques ou persistantes, excepté *K. mutsurensis* Kuw., du Japon signalé sur *Pasania edulis* (Fagacée) et *K. navae* Kuw., vivant sur *Castanea pubinervis*. Le genre se trouve exclusivement réparti dans la Paléarctide et la Néarctide<sup>4</sup>.

Dans la région paléarctique occidentale, le genre *Kermes* comprend toute une série d'espèces dont le statut manque de précision, car, depuis les "Essais" de Signoret déjà anciens, (1874), aucune étude moderne n'est venue préciser l'étude systématique de ce groupement dont l'intérêt biologique est considérable. La morphologie des larves néonates en particulier, qui seule permet une identification certaine des espèces, n'a jamais été faite d'une manière détaillée et comparative pour les espèces d'Europe et du bassin méditerranéen.

Les formes adultes, aux téguments imprégnés de laque, globuleuses, hémisphériques, sont polymorphes et même parfois hétérochromes; leurs caractères microscopiques ne sont pas toujours stables et difficiles à mettre en évidence.

Les formes intermédiaires (larves du 2ème. stade ♂ et ♀) des deux sexes possèdent des caractères plus différenciés, mais ce sont là des stades de croissance rapide dont la fugacité élimine l'intérêt systématique. Les larves néonates par contre, qui se trouvent généralement incluses dans le corps des femelles adultes<sup>5</sup> peuvent être facilement récupérées à l'intérieur de celles-ci, même très longtemps après leur mort, par ébullition dans une solution de potasse caustique à 10 p. 100. Ces larves se retrouvent souvent

<sup>1</sup> Il ne nous est pas possible d'admettre les conceptions de L. Lindinger (1933, p. 117; 1943, p. 148 et 229) qui a substitué au nom de *Kermes* Boitard celui de *Talla* Heyden 1860.

<sup>2</sup> *Hemicoccinae* Maskell = *Kermococcinae* Silvestri = *Kermesiinae* Mc. Gill.

<sup>3</sup> Voir la classification des *Coccoidea*: Balachowsky 1948; p. 248.

<sup>4</sup> *Kermes acaciae* Maskell décrit d'Australie sur *Acacia* ne se rapporte pas au g. *Kermes* Boitard ni à la tribu des *Kermesini*, c'est un *Lecanoidae* de la tribu des *Lecaniini* appartenant au g. *Eulecanium* ou *Cryptes* Crawford.

<sup>5</sup> Les larves néonates émigrent dès leur naissance, mais un certain nombre d'entre elles restent prisonnières dans le corps distendu et sphérique de la ♀ adulte et peuvent être ainsi récupérées.

par milliers dans les tubes ou sachets de collection si la femelle a été récoltée avant la parturition, comme c'est souvent le cas.

La larve néonate possède de nombreux caractères distinctifs qui ont été mis en évidence par K u w a n a (1931) dans son remarquable travail sur les *Kermes* du Japon, qui reste jusqu'ici l'étude la plus approfondie faite sur le g. *Kermes*.

L'étude des nombreux matériaux que nous avons réunis et provenant des différentes régions d'Europe et du bassin occidental de la Méditerranée, nous ont permis de donner les caractères des larves néonates de toutes les espèces connues de ces régions et de préciser par là même, la valeur des différentes espèces de *Kermes* paléarctiques. Malheureusement, nous n'avons pas pu nous procurer les matériaux de *K. greeni* B o d h., *K. nahalchi* B o d h. décrits de la forêt de Nahanal sur *Quercus coccifera* en Palestine (B o d e n h e i m e r 1931) et de *K. mublisi* B o d h. décrit de Turquie (B o d e n h e i m e r 1941<sup>6</sup>) connus tous trois exclusivement par leurs formes adultes et sur le statut desquels il ne m'est pas possible de nous prononcer pour le moment<sup>7</sup>.

\* \* \*

Dans la région paléarctique occidentale, on compte actuellement 5 espèces de *Kermes* qui sont : *K. quercus* L.; *K. roboris* F o u r c.; *K. vermilio* P l a n c h o n; *K. ilicis* L. et *K. bacciformis* L e o n a r d i. Ces cinq espèces se distinguent par les caractères suivants des larves néonates :

— Clef de détermination des larves néonates des *Kermes* d'Europe et du bassin méditerranéen —

- 1 — Cuticle pleuro-dorsale bordée d'épines pointues, courtes et coniques (Fig. 4) ou longues et acérées (Fig. 14, 24) toujours dépourvue de tubercules glandiformes (Fig. 41) ou plats et spatulés (Fig. 33) ..... 2
  - Cuticle pleuro-dorsale exclusivement bordée de tubercules glandiformes (Fig. 41) ou plats et spatulés (Fig. 33) ..... 4
- 2 — Zone pleuro-dorsale de chaque segment abdominal bordée de 2 paires d'épines (2 de chaque côté) courtes et coniques (Fig. 1, 4) *vermilio* P L A N C H O N
  - Zone pleuro-dorsale de chaque segment abdominal bordée d'une seule paire d'épines (1 de chaque côté) longues et acérées (Fig. 10, 20) ..... 3
- 3 — Tarse au moins deux fois plus long que le tibia (Fig. 23) : glandes discoïdales abdominales de structure pentaloculaire ou pluriloculaires (Fig. 26, 27), jamais triloculaire ..... *roboris* F O U R C R O Y
  - Tarse 1<sup>1</sup>/<sub>2</sub> plus long que le tibia (Fig. 15); glandes discoïdales abdominales invariablement triloculaires (Fig. 19) ..... *ilicis* L I N N E
- 4 — Antennes à 3ème. article plus long que le 6ème. et le 1er. (Fig. 31) Cuticule dorsale ornée de tubercules de forte taille, plats, spatulés (Fig. 29, 33). Cuticule ventrale pourvue d'une paire de glandes discoïdales pentaloculaire sur chacun des segments I à V de l'abdomen (Fig. 30, 36) *bacciformis* L E O N A R D I
  - Antennes à 3ème. article plus court que le 6ème. et le 1er. (Fig. 39). Cuticule

<sup>6</sup> Il est probable que *K. mublisi* B o d h. est identique à *K. roboris* F o u r c r o y (v. p. 743).

<sup>7</sup> Nous remercions M. Gérard Langlois, technicien dessinateur à l'Institut Pasteur qui a exécuté les dessins illustrant la présente note, de sa précieuse collaboration.

dorsale ornée de tubercules glandiformes (Fig. 37, 41). Cuticule abdominale totalement dépourvue de glandes discoïdales (Fig. 38) ..... *quercus* LINNE

1 — *Kermes vermilio* Planchon les *Kermes* du Chêne p. 19, Montpellier 1864. syn: *ballotae* Signoret 1874 p. 548.

Descript. Biol. Obs.: Signoret 1874 p. 555 (*vermilio*); Lindinger 1912 p. 286 (*vermilio*) — id — p. 287 (*ballotae*); Leonardi 1920 p. 267; Cecconi 1924 p. 176 — Balachowsky 1931 p. 99; 1932 p. XXVI (*variegatus*) — Gomez-Menor 1937 p. 247; Silvestri 1939 p. 894.

— Caractères de la larve néonate — Long. : 0,450—0,475 mm. Larg. : (metathorax) 0,200 mm. Coloration *in vivo* : rouge vermillon intense.

Micro: Antennes de 6 articles correspondant à la formule : 3, 6, 2 (4, 5, 1). (Fig. 3). Pattes élancées, tibia environ  $\frac{2}{3}$  de la longueur du tarse (Fig. 5).

Cuticule margino-dorsale tapissée par une double rangée d'épines courtes, cônes, et pointues, formant une couronne de 34 épines régulièrement espacées de chaque côté du corps (Fig. 1 et 4). La rangée d'épines internes est insérée presque sur le même plan que la rangée externe, elle comprend des éléments de même taille ou à peine plus réduits. Absence totale d'épines dans la zone médio-dorsale.

Cuticule ventrale (Fig. 2) pourvue de glandes discoïdales disposées comme suit : 1 paire frontale triloculaire au-dessus de l'arc supérieur du tentorium; 1 paire pentaloculaire péri-buccale au niveau du mentum, 1 paire métathoracique identique au niveau des hanches intermédiaires (Fig. 8). Présence en outre d'une glande pluriloculaire au dessus de l'ouverture de chaque stigmate (Fig. 9).

Segments III à V ou II à V de l'abdomen tapissés chacun d'une paire de glandes triloculaires (Fig. 7). Soies abdominales fines et courtes, au nombre de 6 sur chaque sternit (Fig. 2). Anneau anal (8) complet, pluriloculaire, armé de 6 soies anales dont la paire antérieure est la plus développée (Fig. 6). Lobes anaux faiblement prononcés pourvus d'une paire d'épines acérées et d'une paire de longues soies apicales (Fig. 2 et 6).

Caractères de la ♀ adulte — Forme et coloration variables. On distingue deux types distincts suivant que l'espèce vit sur *Quercus coccifera* (forme *typica*) ou *Quercus ilex* et *Quercus suber* (forme *ballotae*). Sur *Quercus coccifera* (forme *typica*) la ♀ est régulièrement sphérique de 6 à 7 mm. de diamètre, d'un brun rouge mate, uniforme et unicolore recouverte d'une très fine pruinosité pulvérulente blanche, ne masquant pas sa coloration foncière (Fig. 47).

Sur *Quercus ilex* et *Q. suber* (forme *ballotae*) la ♀ est moins sphérique (Fig. 48), souvent comprimée latéralement à sa base et moins régulière d'aspect. La coloration foncière est brun jaune franc avec des bandes ou des taches transversales non régulières, formant parfois des zones fondues plus sombres, brun noir.

Cette maculation disparaît souvent (mais non toujours) chez les individus conservés en collection. La taille est généralement plus faible que celle des colonies vivant sur *Q. coccifera* (4,5—5,5 mm.). La forme *ballotae* correspond à *K. ballotae* de Signoret (cf. 1874) alors que la forme typique est *K. vermilio* de Planchon et Signoret. Les caractères des larves néonates des deux formes sont rigoureusement identiques et il s'agit par conséquent d'une seule et même espèce polymorphe comme cela s'observe chez les espèces du genre *Eulecanium*. Nous n'avons jamais trouvé la forme *ballotae* sur *Q. coccifera* ni la forme typique sur *Q. ilex* et l'on peut donc

<sup>8</sup> Chez les larves de *Kermes*, l'anneau anal situé sur le VIII<sup>ème</sup> segment est nettement ventral.



admettre *à priori* pour le moment, que chez cette espèce le polymorphisme et l'hétérochromie sont dus à l'habitat. (Comme chez certains *Eulecanium*)<sup>9</sup>.

Quant aux caractères microscopiques des ♀ adultes, ils sont identiques chez les deux formes :

Antennes courtes, tuberculiformes de 3 articles mal délimités, massue arrondie. Pattes apparemment nulles. Stigmates antérieurs pourvus de nombreuses glandes peristigmatiques et parastigmatiques. Cuticule tapissée de nombreuses glandes tubulaires à conduit faiblement apparent. Marge du corps ornée d'une rangée d'épines courtes, acérées, coniques de même structure que les épines marginales de la larve.

*Biologie — Habitat* — Espèce répandue dans toute la région méditerranéenne occidentale où elle vit sur *Quercus coccifera*, *Q. ilex* et *Q. suber*.

*France* : Montpellier (Hérault) (f. *typica*) sur *Q. coccifera* (Planchon). Ile de Port-Cros; env. d'Aix en Provence (f. *ballotae*) (Balachowsky); Crau (B. du Rh.) (f. *typica*) (P. Vayssière); Env. Ajaccio (Corse) (f. *typica*) (Balachowsky).

*Espagne* : Viciamadrid (Madrid) (f. *typica*) (Gomez-Menor).

*Italie* : Leonardi signale l'espèce sur *Q. ilex*, *Q. coccifera* et *Q. suber* sans précision exacte de localité, Ceconi (1924) mentionne sa présence à Fallonica (Toscane) et en Sardaigne.

*Algérie* : Alger, colline du Hama (f. *typica*); Camp-des-Chênes (Alger) (f. *ballotae*) (Balachowsky). Régaia (Gauthier) (*ballotae*).

*Maroc* : Imouzer, Forêt de la Mamora (J. de Lepiney et Mimeur) sur *Quercus ilex* et *Q. suber*.

Une seule génération par an, l'éclosion des larves a débuté le 2/VI/1928 à Alger et le 3/VII/1939 à Port-Cros (Var), France.

2 — *Kermes ilicis* Linné Syst. nat. X. p. 455 — 1758 —

syn : *baubini* Planchon.

*Descript. Biol. Obs.* Réaumur T. IV 1764 p. 45. — Fonscolombe (B. de) 1834 N° 10 (*ilicis*). — Lichtenstein p. XXXVII, 1870 (*baubini*) — Signoret 1874 p. 188, 549 — Cockrell 1899 p. 270 — Leonardi 1920 p. 271 — Balachowsky 1932 p. XXVI et LVI. — Gomez-Menor 1937 p. 251 (*bacciformis*).

— *Caractères de la larve néonate* — Long : 0,500—0,510 mm., largeur (métathorax) : 0,275 mm., coloration *in vivo* jaune rougeâtre.

— *Micro* — Antenne de 6 articles correspondant à la formula 3—6 (1—2) 5—4 (Fig. 12). Pattes élancées; tarse à peine 1 fois 1/2 plus long que le tibia et légèrement plus court que le fémur (Fig. 15). Cuticule dorsale bordée dans la région pleurale d'une couronne d'épines, acérées, fines, réparties à raison de 1 seule paire seulement sur les segments abdominaux (Fig. 10) et du nombre de 20 à 22 de chaque côté du corps. Ces épines sont faiblement incurvées ou rectilignes (Fig. 14). Cuticule ventrale dépourvue d'épines excepté une paire insérée sur le front, tapissée de soies fines, courtes, disposées à raison de 8 sur chaque segment abdominal (Fig. 11). Glandes discoïdales triloculaires, de faible diamètre, présentes à raison d'une paire sur les segments I à V de l'abdomen (Fig. 11, 19). Présence de glandes analogues, triloculaires, sur le front (1 paire). Autour

<sup>9</sup> Cette coloration est indépendante de la "panachure" sexuelle bien connue chez certains *Eulecanium* car elle s'observerait chez les deux formes au même stade (parturition).

de l'appareil buccal, présence de deux paires de glandes pentaloculaires (Fig. 17). Glandes péristigmatiques au nombre de 3 aux stigmates antérieurs (2 ventrales, 1 dorsale) et de 1 aux stigmates postérieurs (ventrale) de structure pentaloculaire en rosace (Fig. 18). Lobes anaux bien développés, saillants, ornés d'une paire de longues et fortes soies apicales, de 2 épines latéro-internes et de 1 épine latéro-externe. Anneau anal complet, armé de 6 soies dont la paire antérieure est la plus forte (Fig. 16). ♀ Adulte-Sphérique, luisante, lisse, entièrement noire de poix avec des reflets prenant parfois une coloration noir cerise très foncé. Forme sphérique régulière (Fig. 49) ou légèrement irrégulière, surtout chez les individus fixés dans les crevasses des écorces; parfois, la ♀ présente un pli basal autour de l'ouverture abdominale lui donnant un aspect légèrement muriforme comparable à celui de *K. bacciformis* Leon. dont elle ne peut être distinguée par les seuls caractères externes. Région entourant l'ouverture abdominale recouverte d'une pruinosité blanche.

Diamètre : 4,5—7 mm.

*Micro* — Antennes bien développées, relativement longues, de 6 articles avec le 3<sup>ème</sup>. égal ou plus long que les articles 4,5 et 6 réunis. Pattes courtes, massives, mais bien différenciées. Glandes cuticulaires nombreuses, de forme tubulaire, courtes.

— *Biologie* — *Habitat* — Vit presque exclusivement sur *Quercus ilex* secondairement sur *Quercus suber*, localisé aussi bien sur les petites branches que dans les crevasses et fissures du tronc. Répandu dans toute la région méditerranéenne occidentale.

*France* : Environ d'Aix en Provence (B. de Fonscolombe) sur *Quercus ilex*; Vallauris (P. Marchal); Antibes à Menton (C. C.); Côte des Maures et de l'Esterel; Ile de Port-Cros et du Levant (T. C.) (Balachowsky).

*Italie* : Scandici (Toscane) et Cori (Leonardi).

*Afrique du Nord* : Taza (Maroc) sur *Quercus ilex* (R. Maire).

*Espagne* : Villaviciosa, Escorial (Madrid) (Gomez-Menor). Entre Murcie et Grenade sur *Quercus ilex (bacciformis)* (Balachowsky).

Il n'existe aucune indication précise concernant l'aire de répartition géographique de l'espèce dans le bassin oriental de la Méditerranée.

Possède, comme tous les autres *Kermes* paléarctiques, une seule génération par an, la sortie larvaire a lieu au début ou vers le milieu de mai sur le littoral français de la Méditerranée. C'est bien *Kermes ilicis* qui a été utilisé autrefois pour la fabrication de la teinture de *Kermes* et recolté en grand nombre dans les peuplements de chêne vert du midi de la France (Fonscolombe). Beaucoup plus commun que *K. vermilio* Planchon.

3 — *Kermes roboris* Fourcroy — Ent. parisiensis p. 228, 1785 —

*syn*: *pallidus* Reaumur — *variegatus* Gmelin 1788 — *variegatus* v. *corticalis* Nassonow 1909 — *mulhisi* Bodenheimer 1944 (?).

*Descr. Biol. Obs.* Signoret 1874 p. 308 — Newstead 1903 p. 141; Cecconi (G.) 1924 p. 175 — Knechtel 1929 p. 6 — Borkhesnius 1936 p. 619, 1937 p. 64. — Silvestri 1939 p. 696 —

*Larve néonate*: Longueur 0,600 mm., largeur (métathorax) = 0,275 mm.

Coloration *in vivo*: rouge vermillon vif.

*Micro* — Antenne de 6 articles correspondant à la formule 3.6 (1.2.4) 5 — Massue purvue de 3 macrochètes (Fig. 22).

Pattes longues et élancées, relativement fines; tarse très long, dépassant ou égalant

le double de la longueur du tibia et nettement plus long que le fémur (Fig. 23). Mentum très long, aux derniers articles étroitement triangulaires. (Fig. 21).

Cuticule dorsale exclusivement ornée dans toute la zone pleurale, d'une rangée de fortes et longues épines acérées, légèrement incurvées (Fig. 24) formant une bordure régulière, sur les segments abdominaux, on ne trouve qu'une seule paire d'épines par segment et l'on compte 22 épines pour chaque côté du corps, auxquelles il convient d'ajouter une paire d'épines supplémentaire frontales (Fig. 20).

Cuticule sternale dépourvue d'épines analogues à la face dorsale (excepté pour la paire frontale). Céphalothorax orné ventralement de grosses glandes pentaloculaires ou pluriloculaires (Fig. 26 et 27), disposées comme suit : 1 paire frontale, 2 paires péribucales, 1 paire métathoracique, 3 paires aux stigmates antérieurs (dont 1 dorsale), 1 paire aux stigmates postérieurs. Glandes sterno-abdominales disposées au nombre de 1 paire sur les segments I à V de l'abdomen, de structure pentaloculaire (Fig. 21 et 28).

Soies abdominales courtes, petites, fines, au nombre de 8 sur chacun des 5 premiers segments abdominaux. (Fig. 25).

Anneau anal complet, orné de 6 soies fines. Lobes anaux saillants, en dehors de la paire de longues et fortes soies apicales, on trouve des soies fortes plus courtes, spiniformes, au nombre de 3 paires dont 2 paires internes et 1 externe (Fig. 25).

Présence, en outre, d'une paire de soies fines dorsales à la naissance du lobe.

♀ adulte = Régulièrement sphérique, de 6 à 8 mm, de diamètre, de coloration foncière variant du brun jaune clair au rouge orangé foncé, avec des zones brunes très foncées (mais non noires) formant des taches transversales, se rejoignant parfois l'une l'autre et donnant à l'insecte un aspect marbré très caractéristique (Fig. 50). Ces taches subsistent chez les individus en collection.

*Micro* — Antennes de 3 articles, courtes, à segmentation faiblement différenciée. Pattes courtes, massives, à pièces visibles et séparées par de simples sutures, non spiniformes. Cuticule tapissée de nombreuses glandes tubulaires. Stigmates antérieurs pourvus de nombreuses glandes péristigmatiques. Marge du corps ornée de courtes et fines épines.

*Biologie* — *Habitat* — Espèce euro-sibérienne, suivant à peu près la zone de répartition des chênes à feuilles caduques. Répandu dans toute l'Europe tempérée, mais non signalé en Afrique du Nord, ni dans la plupart des régions basses circo-méditerranéennes.

Vit sur *Quercus robur* et *Q. pedunculata*, se localise essentiellement sur les rameaux, semble préférer les sujets de petite taille et buissonnants.

L'aire de répartition actuellement connue est la suivante :

*France* : Env. d'Aix en Provence (Fonscolombe 1834) (in col. Mus. H. N.) Hyères (Signoret). Forêt de Château Charles (Allier) (P. Marchal). Bois du Rouvray (Seine Inf.); Bois de Meudon à Viroflay (S. & O.); Forêt de Rambouillet (S. & O.) (A. C.) (Balachowsky).

*Angleterre* : Signalé par Newstead (cf. 1903) et Green (1928); rare et localisé. (Blean Woods, Herne (Kent).)

*Italie* : Trouvé par Leonardi (1920) et Silvestri (1939 p. 696). — Signalé par Cecconi (1924) comme fréquent en Venétie.

*Tchécoslovaquie* : Podbaba (Bohême) (Sulc).

*Roumanie* : Comana, Purcari, Babadag (Knechtel).

*U. R. S. S.* : Signalé par Cholodkowsky, Nassonov, Kiritchenko (1932 p. 310), Borkhesnius (1937) dans diverses localités d'Ukraine, Bessarabie

et de Russie blanche sur les chênes avec des variations locales de coloration chez les adultes.

*Pologne* : Signalé dans diverses localités par Kiritchenko (cf. 1932 p. 311).

*Turquie* : Il est probable que l'espèce sommairement décrite et figurée par F. S. Bodenheimer sous le nom de *Kermes mublisi* (cf. 1941 p. 76) se rapporte à *K. roboris*. Cet auteur l'a recoltée dans les montagnes de Fineke et Manavgat (Prov. Antalya) sur petites branches de *Quercus* sp. (du type *ilex*).

4 — *Kermes bacciformis* Leonardi Bol. Lab. Zool. gen. agr. III p. 156 Portici 1908.

*Descr. Biol. Obs.* : Leonardi 1908, V, 1920 p. 275 — Cecconi (G.), 1924 p. 177.

*Caractères de la larve néonate* : Longueur : 0,480—0,500 mm., largeur (métathorax) : 0,250 mm. Coloration de la larve *in vivo* jaune citron (Leonardi).

*Micro* : Antennes de 6 articles correspondant à la formula : 3, 6, 1 (2—4), 3. 6ème. article pourvu de 3 macrochètes en dehors des longues soies apicales (Fig. 31). Pattes robustes, massives; tibia 1/3 de la longueur du tarse. Fémur à peine plus court ou égal au tarse (Fig. 32). Cuticule dorsale ornée de gros tubercules très caractéristiques de forme large, aplatie, spatulée, légèrement élargis vers l'apex (Fig. 29, 33), bordant en une seule rangée toute la zone pleuro-dorsale et présents également, dans la zone médio-dorsale. Les spatules marginales (Fig. 29) sont plus petites que les spatules médianes et forment une bordure de 18 éléments de chaque côté du corps. Sur les segments abdominaux, on compte une paire de spatules par tergite. Spatules médio-dorsales disposées dans la région céphalo-thoracique et abdominale comme l'indique la figure 29. Sur l'abdomen, on remarque 3 à 4 grosses spatules par segment en dehors des spatules marginales (Fig. 34). Cuticule ventrale totalement dépourvue de tubercules spatulés, soies présentes sur les segments abdominaux à raison de 4 par segment (Fig. 34). Glandes discoïdales pentaloculaires disposées comme suit : 1 paire frontale, 2 paires péribuccales, 1 paire métathoracique, (Fig. 35), 1 paire sur chacun des segments I à V de l'abdomen (Fig. 36). Stigmates antérieurs et postérieurs pourvus d'une seule glande pentaloculaire ventrale.

Lobes anaux faiblement marqués; en dehors de la paire de longues soies apicales, présence sur le lobe d'une paire de fortes spatules et d'une paire d'épines émoussées (Fig. 34).

♀ *adulte* — Coloration entièrement noire de poix, luisante, taille forte, de 5 à 7 mm. de forme globuleuse, subsphérique avec une légère compression longitudinale et transversale lui donnant l'aspect muriforme d'une baie, les 4 lobes formés par ces sillons sont bien marqués, mais ne font pas saillie. Entre les lobes la cuticule est finement crevassée chez certains individus (Fig. 51). La forme et la couleur de *K. bacciformis* se retrouvent chez certains *K. ilicis* L. et les deux espèces ne peuvent être différenciées avec certitude que par les caractères microscopiques des larves néonates.

*Micro* — (d'après Leonardi) — Antenne de 6 articles correspondant à la formule 3—1 (2—6), 4—5. Pattes massives, mais à pièces différenciées. Cuticule tapissée de glandes auréolées et de plaques glandulaires sombres à pourtour réticulé.

*Biologie — Habitat* — Connue exclusivement par les colonies décrites par Leonardi d'Italie, signalé par cet auteur à Bosco-Mantico (Vérone) et en Calabre, vivant sur *Quercus suber* et *Quercus cerris*.

Cette espèce est très proche par les caractères de sa larve néonate de *Kermes mutsurrensis* Kuwana (cf. 1931, p. 26) décrit du Japon.

La présente étude a été faite sur des individus originaires de Calabre récoltés par Leonardi (in *Chermotheca italica*) qui nous ont été communiqués respectivement par P. Vayssière et F. Silvestri auxquels nous adressons ici nos remerciements.

5 — *Kermes quercus* Linné Syst. nat. X. p. 455, 1758 —  
syn.: *reniformis* Geoffroy 1762, *cordiformis* Lindinger 1912 (?)<sup>10</sup>.

*Descrip. Biol. Obs.* Reaumur T. IV, 1738; Signoret 1874 p. 89, 553 — Cockrell 1899 p. 270; King 1901 p. 259; Newstead 1903 p. 142; King et Rey, 1901 p. 13 — Nasonov 1910 — Wünn (H.) 1925 p. 428 — Knetchel 1929 p. 6 — Borkhesnius 1936 p. 119 — 1937 p. 64 —

— *Caractères de la larve néonate* — Longueur: 0,300—0,325 mm.; largeur (méthorax) 0,125—0,130 mm. Coloration in vivo, brun rouge foncé.

— *Micro* — Antenne de 6 articles correspondant à la formule 6.2.1. (3.4.5.). Le 3ème. article n'est pas le plus développé, contrairement à celui de toutes les autres espèces européennes (Fig. 39). Pattes courtes, massives, épaissies. Tarse un peu plus long que le tibia et légèrement plus court que le fémur (Fig. 40).

Cuticule dorsale bordée dans toute la zone pleurale de tubercules glandiformes arrondis, courts, ovoïdes (Fig. 37, 41), de petite taille formant une rangée régulière de 17 éléments de chaque côté du corps. Sur les segments abdominaux I à VIII, présence d'une paire de tubercules marginaux par segment. Zone médio-dorsale pourvue également de tubercules analogues à ceux de la zone marginale répartis à partir du mésothorax jusqu'au segment III ou IV de l'abdomen où ils sont disposés par paire sur chaque tergite. Sur les segments IV, V et VI ou seulement V et VI (suivant les individus), les tubercules sont remplacés par une paire de soies courtes et raides (Fig. 37). Présence à partir du mésothorax et sur tous les segments abdominaux de 4 rangées de pores minuscules uniloculaires ( $d=1\ \mu$ ), à lumière obscure (Fig. 43), disposées régulièrement sur chaque tergite et visibles que sous fort grossissement.

Cuticule ventrale ornée dans la zone margino-sternale du corps d'une rangée de petites soies courtes et espacées (Fig. 38); on compte 15 à 16 soies pour chaque moitié du corps. Sur l'abdomen aux soies marginales s'ajoutent des soies médio-abdominales réparties à raison de 6 éléments sur chacun des segments I à VI inclusivement (Fig. 38, 42).

Absence totale de glandes discoïdales de gros diamètre sur les faces dorsales et ventrales de l'abdomen.

Présence de glandes discoïdales de gros diamètre ( $d=6\ \mu$ ) de chaque côté de l'appareil buccal (une paire à la base, l'autre à l'extrémité du mentum) (Fig. 44). Stigmates antérieurs et postérieurs pourvu d'une seule glande discoïdale pentaloculaire ventrale de diamètre inférieur à celui des glandes péribucales ( $d=4\ \mu$ ) (Fig. 45) et d'une paire de glandes triloculaires dorsales (Fig. 46). Stigmates postérieurs pourvus exclusivement d'une paire de glandes ventrales pentaloculaires. Anneau anal incomplet, orné de 6 courtes soies, très fines. Lobes anaux arrondis, très faiblement saillants, terminés par une paire de soies filiformes très souples, et 3 paires de soies plus courtes. Base du lobe ornée en outre d'une paire de tubercules ovoïdes (Fig. 42).

<sup>10</sup> La description de Lindinger (cf. 1912, p. 286) est inutilisable.

♀ *adulte* — Forme globuleuse, légèrement aplatie latéralement et parfois étirée vers la cavité abdominale, souvent irrégulière avec la zone dorsale lisse luisante et arrondie (Fig. 52); 3 à 4 mm. Coloration très foncée, noire ou brun rouge très foncé.

*Micro* — Antennes courtes, de 3 articles à sutures peu distinctes. Pattes courtes, peu différenciées, tarse spiniforme prolongé par un crochet non recourbé. Stigmates entourés de nombreuses glandes péristigmatiques et parastigmatiques. Cuticule ornée de nombreuses glandes tubulaires à conduit asymétrique et de zones d'épaississements cuticulaires dorsales.

— *Habitat* — Vit sur *Quercus robur* et *Quercus pedunculata*, en colonies généralement nombreuses dans les fissures des écorces, principalement sur le tronc des arbres âgés et de grande taille. Souvent localisé sur un même arbre laissant indemnes les arbres voisins. Répandu à l'état sporadique dans toute l'Europe tempérée.

*France* : Reaumur (T. IV, 1738) a vu l'espèce dans le Poitou et en a donné une bonne description, mais Signoret ne l'a jamais observée. Nous l'avons trouvée en abondance sur de vieux chênes de la forêt de Saint-Germain, de Rambouillet et au bois de Meudon à Viroflay (Seine et Oise).

*Suisse* : Signalé à Lausanne par P. Marchal (1 individu).

*Angleterre* : King et Newstead signalent l'espèce dans plusieurs localités d'Angleterre.

*Hollande* : Renkum et Sittard (Limburg)<sup>10</sup> (Van der Goot).

*Allemagne* : Borstel près Hambourg (Rey.) Bade (H. Wünn).

*Tchécoslovaquie* : Signalé par Sulc. à Trebon et Prague.

*U. R. S. S.* : Commun dans toute la Russie ou il suit l'aire de repartition des chênes (Kiritchenko 1932 p. 311). Detskoïe sélo (env. Leningrad) (Nassonow) provoque le dépérissement des chênes.

*Pologne* : Env. de Varsovie et diverses localités (Kiritchenko 1932 p. 311).

La biologie de cette espèce qui n'a qu'une seule génération a été étudiée par Nassonow (cf. 1910) aux environs de Léningrad.

*Remarques* — *K. quercus* L., est très voisin de *K. nakagavae* Kuw., décrit du Japon (cf. 1931 p. 21) qui s'en rapproche non seulement par les caractères des larves néonates mais aussi des ♀ adultes.

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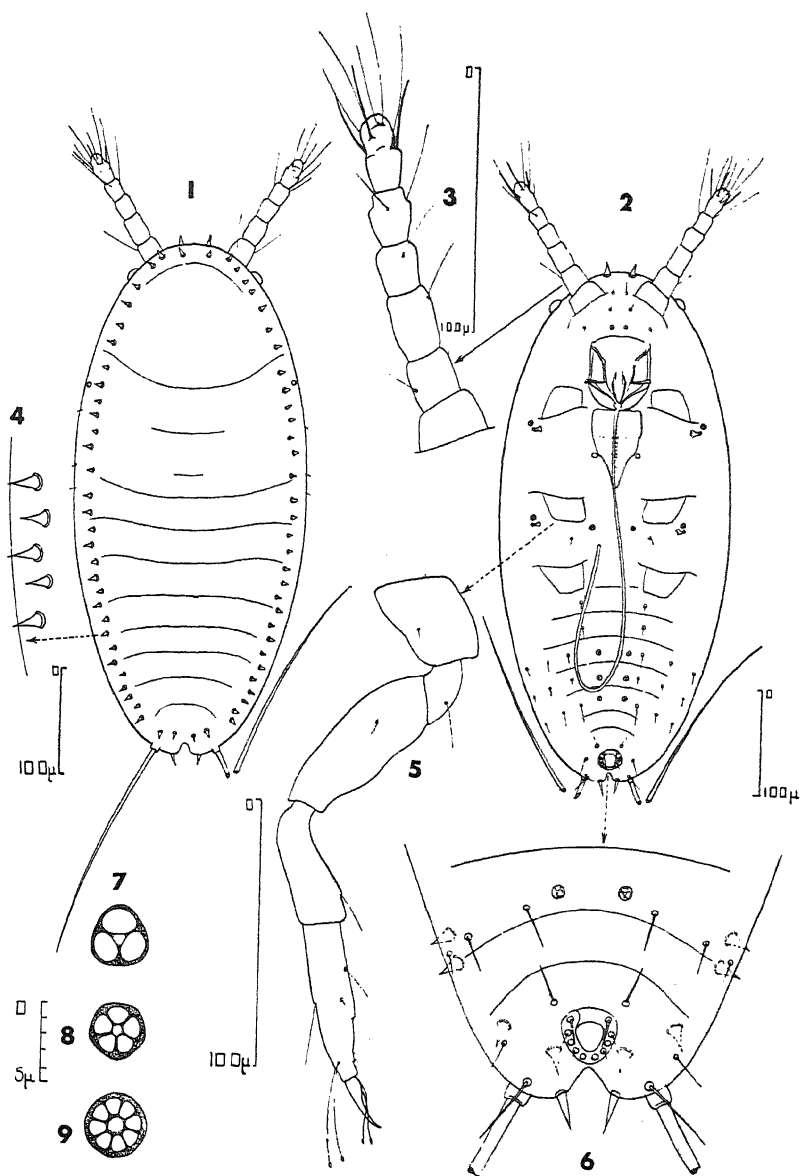


Planche I — *Kermes vermilio* Planchon (larve néonate) : 1 — Face dorsale; 2 — Face ventrale; 3 — Antenne; 4 — détail des épines marginales; 5 — patte intermédiaire; 6 — Extrémité abdominale; 7 — Glande sterno-abdominale; 8 — glande péribuccale; 9 — Glande péristigmatique (variation).



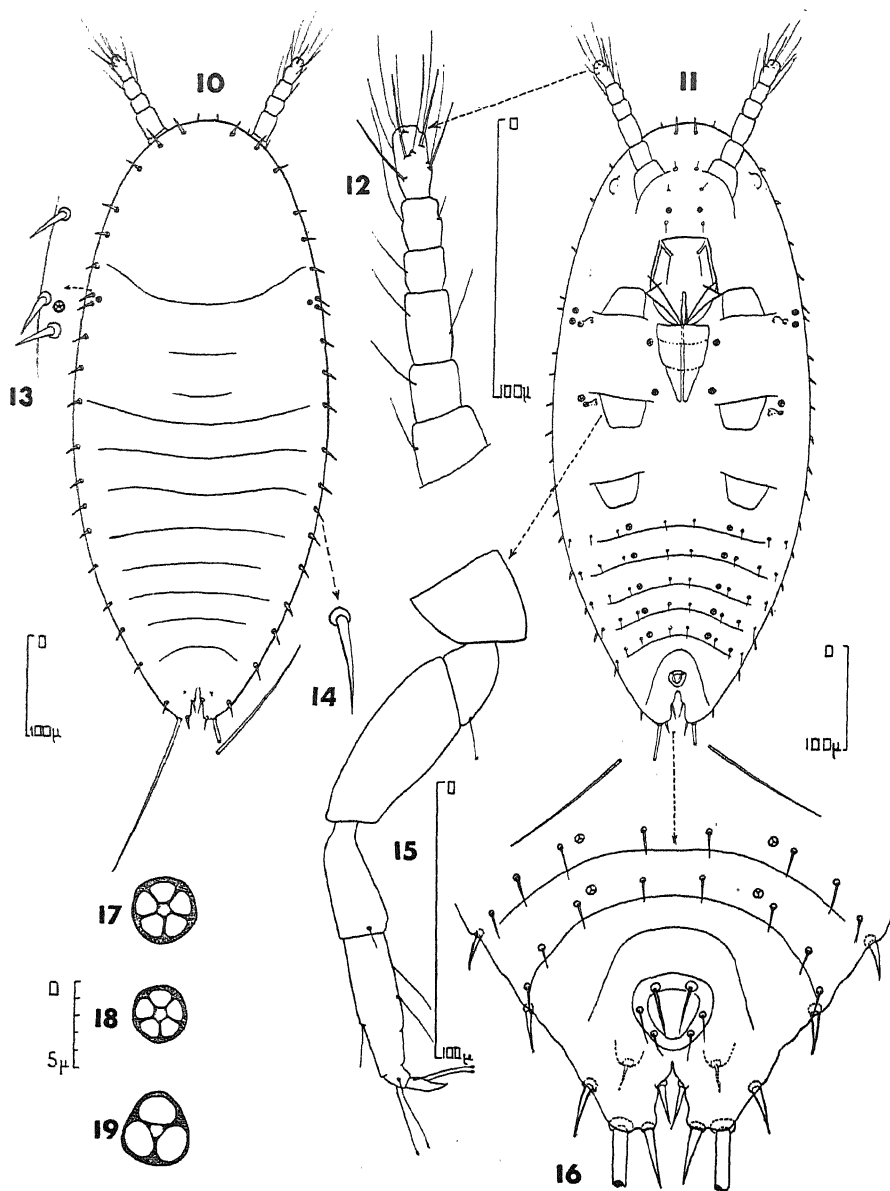


Planche II — *Kermes ilicis* Linnaeus (larve néonate) : 10 — Face dorsale; 11 — Face ventrale; 12 — antenne; 13 — Epines marginales péristigmatiques; 14 — épine marginale (détail); 15 — Patte intermédiaire; 16 — Extrémité abdominale; 17 — Glande pentaloculaire péri-buccale; 18 — Glande péristigmatique; 19 — Glande triloculaire sterno-abdominale.

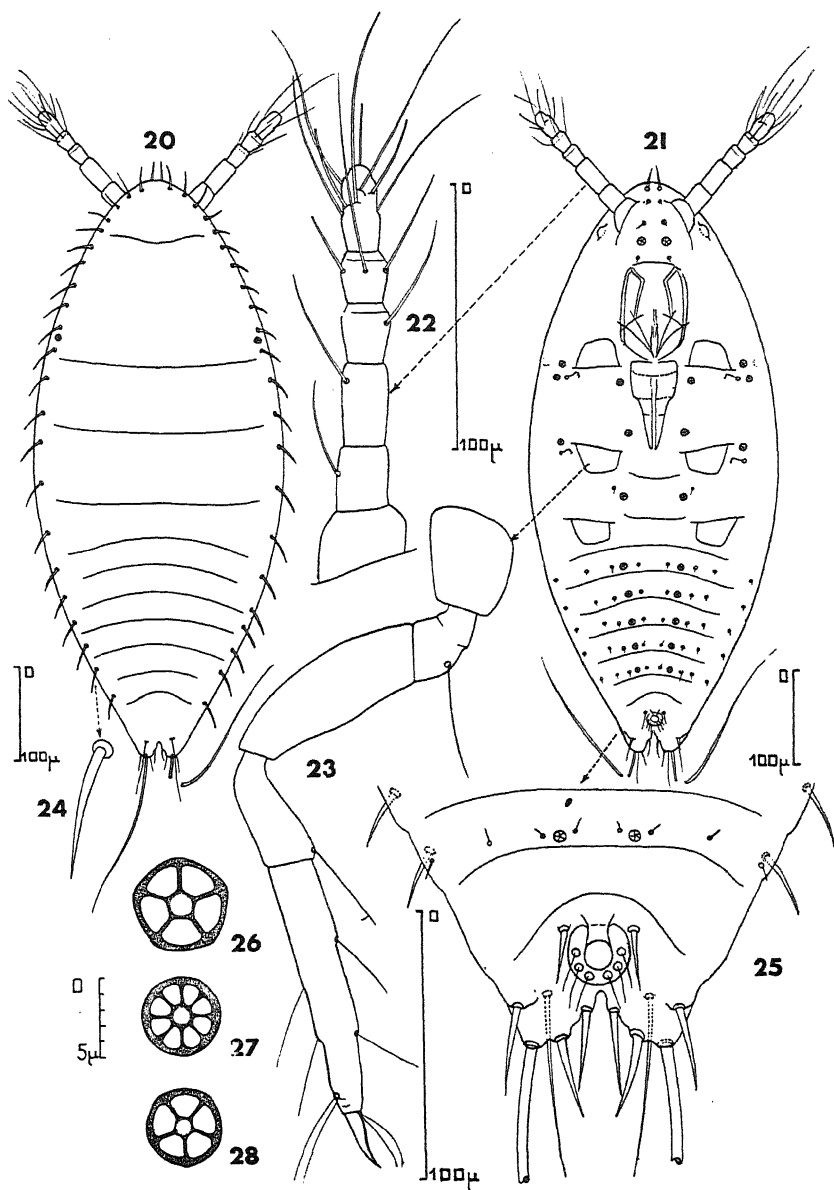


Planche III — *Kermes roboris* Fourcroy (larve néonate); 20 — Face dorsale; 21 — Face ventrale; 22 — antenne; 23 — Patte intermédiaire; 24 — épine marginale (détail); 25 — Extrémité abdominale; 26 — Glande pentaloculaire sterno-abdominale; 27 — Glande péristigmatique pluriloculaire (variation); 28 — Glande péristigmatique pentaloculaire (normale).

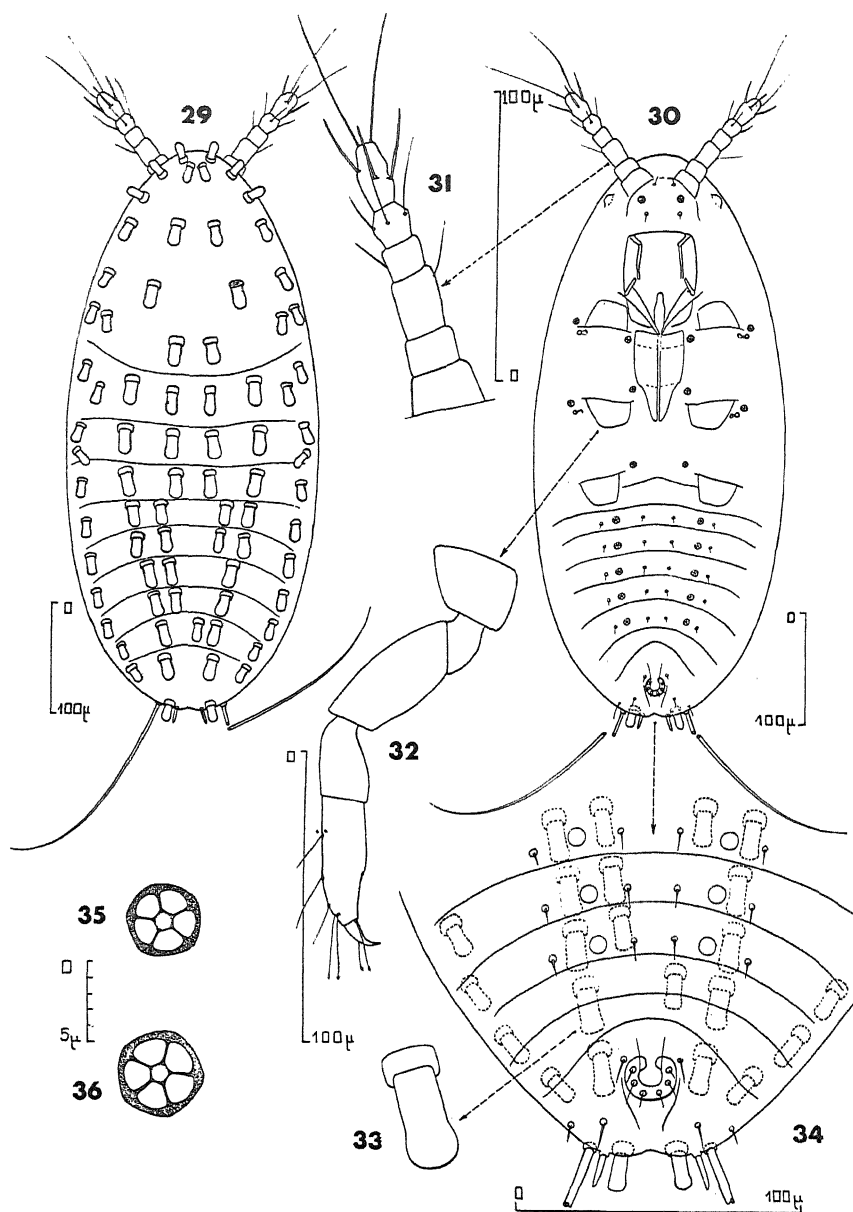


Planche IV — *Kermes bacciformis Leonardi* (larve néonate) : 29 — Face dorsale; 30 — Face ventrale; 31 — Antenne; 32 — patte intermédiaire; 33 — Tubercule spatulé médio-dorsal (détail); 34 — Extrémité abdominale; 35 — Glande pentaloculaire péristig-matique; 36 — Glande pentaloculaire sterno-abdominale.

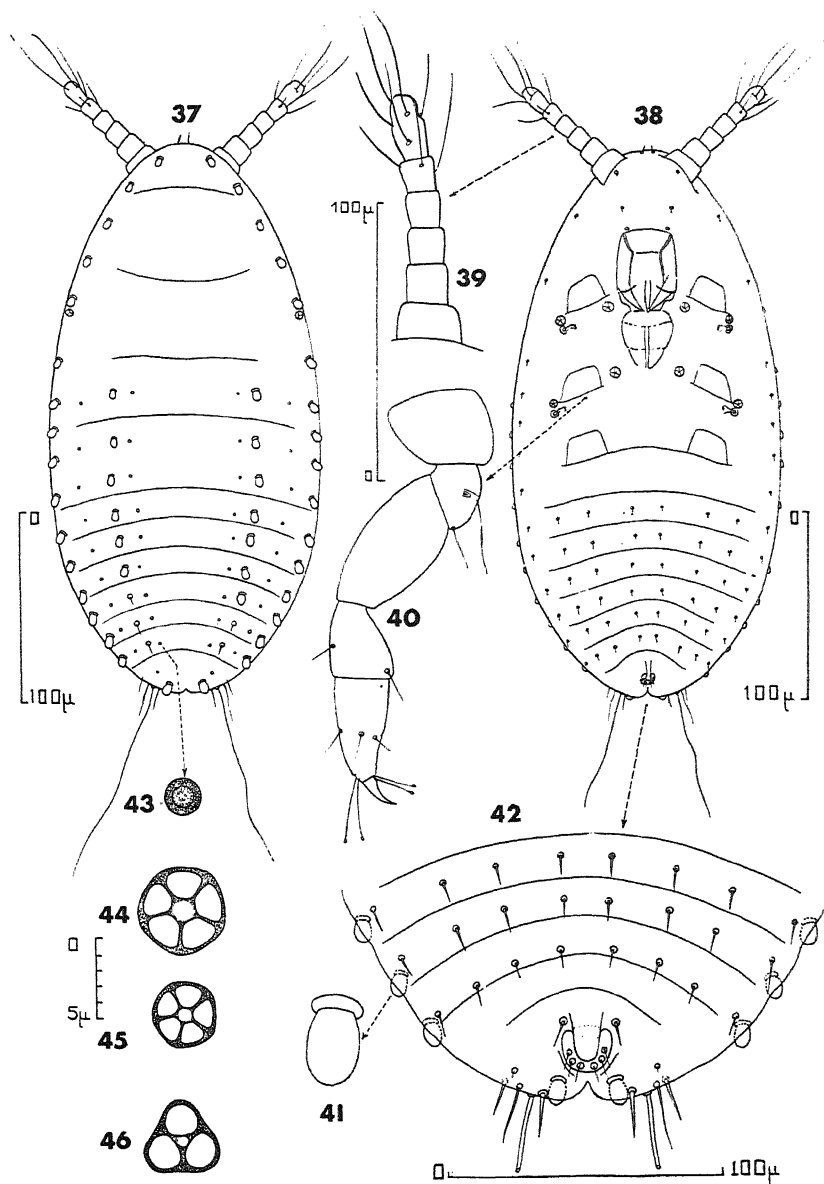


Planche V — *Kermes quercus* Linné (larve néonate); 37 — Face dorsale; 38 — Face ventrale; 39 — antenne; 40 — Patte intermédiaire; 41 — Tubercule glandiforme marginal (détail); 42 — Extrémité abdominale; 43 — Pore dorso-abdominal; 44 — Glande pentaloculaire péribuccale; 45 — Glande pentaloculaire péristigmatique ventrale; 46 — Glande triloculaire péristigmatique dorsale.

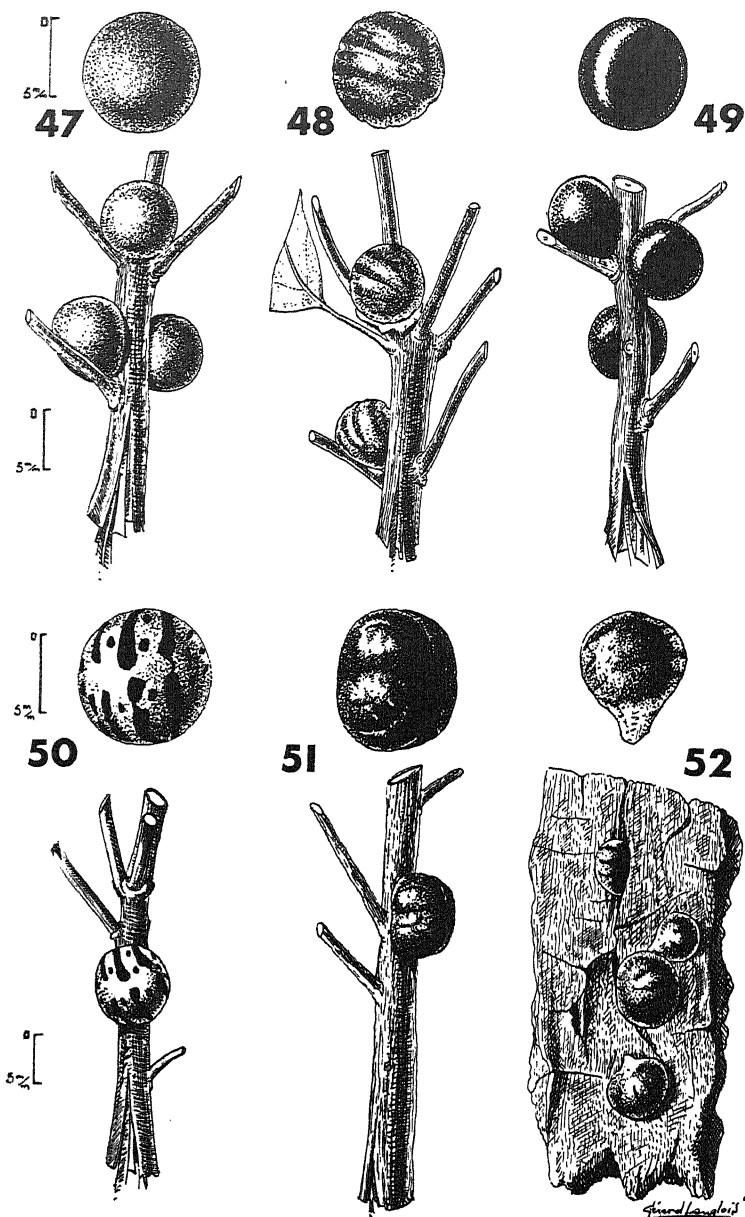


Planche VI — 47 *Kermes vermilio* Planchon (♀ adulte) forme typica (brun rouge foncée uniforme); 48 — *Kermes vermilio* Planchon (♀ adulte) forme ballotae (brun jaune zonée de taches plus sombres).

Fig. 49 — *Kermes ilicis* L. (♀ adulte, noir cerise ou noir uniforme).

Fig. 50 — *Kermes roboris* Fourc. (♀ adulte, brun jaune zonée sombre).

Fig. 51 — *Kermes bacciformis* Leon. (♀ adulte, noir uniforme luisante).

Fig. 52 — *Kermes quercus* L. (♀ adulte, noire cerise ou noire uniforme, luisante).

## THE STATUS OF FOREST INSECT PESTS IN IRELAND

By *J. Carroll*

Very little has been published regarding the insects which attack forest trees in Ireland. Therefore, in order to make some knowledge available concerning such insects this paper is presented to the 8th International Congress of Entomology. The data in the paper is based almost entirely on the results of a four year survey of the forest insects of Ireland which has recently been completed by D. A. Quirke, Ph.D.

At the outset it should be mentioned that upland areas in Ireland especially mountain tops have scarcely borne any timber since the bronze age (1000—500 B.C.). Up to the 17th century woodlands were fairly extensive in the lowlands and consisted principally of hardwoods e.g. Oak, Ash, Elm, Holly etc. Since the 17th century there has been much felling and clearing of such areas with the result that at the present time the proportion of the land occupied by woodlands is only about 1.3 %. In recent times various species of trees (particularly conifers) have been introduced and such introduced species are now being extensively planted. Such woodlands as now exist comprise about 26 % softwoods, 48 % mixed woods and 26 % hardwoods. The conifers are mostly pines (predominantly Scots), Norway and Sitka Spruce, European and Japanese larch, with small amounts of Silver firs, Douglas fir and Cupressus species.

The forest insects of Ireland may be divided into three groups namely:

- I. A group comprising a relatively small number of species which are of widespread distribution and capable of causing conspicuous and often great damage to the trees on which they occur. The members of this group are ranked as major pests.
- II. A somewhat larger group comprising insects which are of less widespread distribution and which do not cause such a conspicuous amount of damage. The members of this group are ranked as intermediate pests.
- III. A large group comprising insects which although they occur to varying degree do not as a rule cause damage of a conspicuous or serious nature. The members of this group are ranked as minor pests.

## GROUP I.—MAJOR PESTS

*Order Hemiptera*

Among the true aphids the only species of major consequence is the Green Spruce Aphis (*Neomyzaphis abietina*). It has a widespread distribution and in general spruce throughout Ireland suffers severely from attack by it. Attack on sitka spruce is generally much more severe than on Norway spruce.

It is usually very severe on nursery stock of sitka spruce and also on spruces during the first year after they have been planted in the forest. During the following five years attack is usually light but from about the 6th till the 20th year it may again be heavy, particularly on sitka spruce.

The aphid attack on spruce in Ireland has been found most severe on trees in shade or partial shade and in frost areas and very exposed situations. On account of the relative mildness of the Irish winter and the scarcity of predators the aphid

survives quite well during the dormant season and this seems to account in part for its abundance and importance.

#### *Adelges species*

Six species of *Adelges* are known to occur in Ireland viz: *abietis*, *strobilobius*, *pini*, *nüsslini*, *picea* and *cooleyi*.

Primary hosts of *abietis* and *strobilobius* are Norway and sitka spruce and *Picea morinda* and secondary hosts are larch. No primary hosts for *pini*, *nüsslini* and *picea* have been noted. Secondary host for *pini* are pines and for *nüsslini* and *picea* are silver fir.

Sitka spruce and *Picea alba* are known primary hosts for *cooleyi*, the Douglas fir being the secondary host.

All the *Adelges* species are of common occurrence on the secondary hosts. As regards *Adelges* galls on spruce heaviest infestations are undoubtedly those of *Adelges abietis* and these are generally most severe on trees which have been planted out 6—15 years. Generally the degree of galling is light or moderately light and consequently of small consequence. Occasionally however, the degree of galling may be heavy and when galls occur on leading shoots of young spruce, as they sometimes do, the effect on growth may be serious.

Colonies of *A. abietis* on larch are often common and extensive and may interfere seriously with growth.

Colonies of *A. pini* are of common occurrence on pines (particularly Scots). They have been found on nursery stock and on young trees up to 15 years planted, particularly where pines are growing in bad ecological environment.

Colonies of *A. nüsslini* and *A. picea* are often common and extensive on silver fir and the occurrence of these species renders it almost impossible to have healthy silver firs in some localities. Much more silver fir would undoubtedly be grown in some districts were it not for the presence of these species.

Galls of *A. cooleyi* occur on sitka spruce of all ages except those less than six years planted, most generally on lateral but occasionally on leading shoots. The presence of such galls is generally of little economic importance. In those places where Douglas fir is grown to some extent colonies on it occur on trees planted 4 years and longer. Attack is generally severe on trees planted more than 9 years—even on old trees. Bad attack may result in loss of all needles on current year's shoots and hence serious retardation of growth may occur. Again it is likely that more Douglas fir would be grown in certain areas suitable for it if *Adelges cooleyi* did not occur.

#### *Scale Insects*

*Chionopsis salicis* occurs on willows and alders but in Ireland is of most importance as a pest of ash. It is most abundantly found on branches from 7 to 20 cms. diameter—also on smaller branches but seldom on the trunk. It is always worst where ash is in much shade and where drainage is bad. The occurrence of this insect causes the wood of ash to be brittle and of inferior quality. This effect on the quality of the wood gives *Chionopsis salicis* a particular economic importance.

#### *Order Coleoptera*

Only one member of the *Coleoptera* i.e. the large pine weevil, *Hylobius abietis* comes into the group of major pests. It is of common occurrence—principally on Scots pine and to a lesser extent on other conifers. Great numbers of young trees are injured

to varying degree but the number fatally injured is generally small except where the attack is for 3 or 4 consecutive years.

#### Order Lepidoptera

The most important member of the *Lepidoptera* is the pine shoot moth, *Evetria buoliana*. Trees less than two years planted out are not attacked. Infestation is most severe on trees planted from 8 to 18 years particularly on pines planted pure. Attack is often severe on both leading and lateral shoots causing obvious effects on development of the trees. Parasitism seems to be of little account.

The Tineid, *Prays curtisellus*, occurs commonly on ash with caterpillars mining in leaves and attacking buds. Attack is generally most severe on ash planted less than 20 years particularly where ash is planted pure.

### GROUP II.—INTERMEDIATE PESTS

#### Order Hemiptera

The Beech aphid, *Phyllaphis fagi*, occurs commonly on beech trees of all ages in the forest and on nursery stock. Sometimes its presence on nursery stock is a matter of importance but on the whole this aphid cannot rank as a major pest.

#### Order Coleoptera

Among the weevils a number of species rank as pests of intermediate importance.

*Otiorrhynchus picipes* attacks a number of broad leaved trees and also conifers particularly silver fir. In some cases damage of a conspicuous nature to leaves and shoots is caused.

The same remarks apply to *Strophosomus melanogrammus*, but this species has greatest importance by reason of its attack on spruce.

The leaf weevil *Phyllobius viridiaeris* sometimes causes a conspicuous amount of defoliation of young broad leaved trees particularly beech and oak.

The beech weevil *Orchestes fagi* occurs commonly, and the leaves of beech trees of all ages can be extensively bitten in shot hole fashion by the adults and mined by the larvae.

#### Bark Beetles

In Ireland there is a smaller fauna of bark beetles than in Britain. All species have been found using dead trees, felled trees or dead branches on living trees for breeding. On dead trees they have been found breeding in roots, trunks and branches. Host trees of bark beetles recorded during the survey are pines (various species), European larch, Norway spruce, oak, ash, beech, elm and to a very minor extent some other trees.

The species of bark beetles which we have can only rank as of secondary or minor importance but possibly could become more important with a progressive extension of Irish woodlands.

Species which can be listed in the group of Intermediate pests are:

*Myelophilus piniperda* on pines.

*Hylastes ater* on pines.

*Hylurgops palliatus* on spruce and larch.

All other species of bark beetles which occur are of very little importance.

#### Order Lepidoptera

The tineid *Argyresthia atmoriella* whose caterpillars burrow in the shoots of larch is of widespread distribution but the extent of the damage it causes is of a rather



limited nature. It is more common on European than on other larches but even where attack is most severe not more than 10 % of the terminal leading shoots have been burrowed.

Species of *Evetria*, exclusive of *E. buoliana* (already dealt with) recorded as pest of pine in Ireland are :

*E. turionana*, *E. pinivorana* and

*E. resinella*.

These species are of much less common occurrence and of much less importance than *E. buoliana*.

The green oak tortrix, *Tortrix viridana*, has a moderately widespread distribution but it seldom gains great numerical strength. In areas where it has been noted during the period of the survey it occurred on not more than 10 % of the trees and it was estimated that not more than about 2 % of the foliage of these trees was consumed.

#### Order Hymenoptera

The most important Hymenopterous pest is the pine sawfly *Diprion pini*. It has a widespread distribution occurring most commonly on Scots pine and *Pinus contorta* and to lesser extent on other pines. Although it does attack very young trees recently planted out heavier attack has been on trees planted from about 5 to 12 years. Trees attacked are usually badly defoliated, but seldom more than about 3 % of the trees in any area are attacked. Because of this fact the pine sawfly cannot be regarded as major pest.

*Diprion sertifer* and the large larch sawfly *Lygaeonematus erichsoni* are of very much less common occurrence than *Diprion pini* and are only of minor importance.

### GROUP III.—MINOR PESTS

This group contains a very large number of species which have been recorded on woodland trees, but which are of very little economic importance because of the insignificant amount of damage which they cause.

In the order *Hemiptera* are included a number of *Aphis* species and also some species of the families *Psyllidae*, *Coccidae*, *Cicadidae* and *Capsidae*.

In the order *Coleoptera* are included a number of species from the families—

*Curculionidae*, *Chrysomelidae*, *Anobiidae*, *Scarabaeidae*, *Elateridae*, *Cerambycidae*.

Many species of moths from at least 8 different superfamilies of the *Lepidoptera* have been recorded.

From the *Hymenoptera*, the wood wasp *Sirex gigas*, various species of sawflies, two species of seed flies (*Tormidae*) and various species of the superfamily *Cynipoidea* have been recorded.

From the Order *Diptera*, species of the families *Bibionidae*, *Tipulidae* and *Cecidomyiidae* have been recorded.

Members of the *Acarina* occur but are of very minor importance. A number of species, occurring entirely in the family *Eriophyidae*, has been recorded.

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## **Dendroctonus micans KUGEL, A PEST OF SITKA SPRUCE IN THE NETHERLANDS**

By *E. T. G. Elton*

### *Introduction.*

*Dendroctonus* is a genus of bark beetles, most of the species of which are primary enemies of coniferous trees. Most species of the genus are endemic in North America. There is only one European species: *Dendroctonus micans* Kugel. Its original food plant is Norway spruce (*Picea abies* Karst. = *P. excelsa* Link.). Although Norway spruce had been planted in the Netherlands for several centuries, and although the beetle had always been present close to the Dutch frontier in Germany and Belgium, *D. micans* was never found in the Netherlands, and was not regarded as belonging to the Dutch fauna until 1935. In that year the beetle suddenly appeared in great numbers near Putten and Nunspeet (11, 12; fig. 1). The trees infested, however, were not Norway spruce, but *Picea orientalis* Carr. and Sitka spruce (*Picea sitchensis* Carr.), the infestation of the latter species being the more important on account of its greater abundance. Since its first appearance in these two outbreaks *D. micans* has continued to be the most important pest of Sitka spruce in the Netherlands (4, 14, 15, 16, 17).

### *Dendroctonus micans* in the Netherlands.

The outbreak near Putten (11, 12) actually started in *Picea orientalis*, but soon spread to Sitka spruce standing nearby. The outbreak near Nunspeet, discovered a few months later, had its origin in a stand of Sitka spruce. On account of the infestation the whole stand (0.77 hectare = nearly 2 acres) had to be felled in the course of the following four years. After these two outbreaks there was an interval until 1943; then a series of others followed one another in rapid succession. Some of these outbreaks have already led to the complete removal of all Sitka spruce over a certain age in the affected area. The locations and dates of these outbreaks are given in fig. 1. The dates indicate the years in which the infestations were first noticed. In most cases, however, the beetles must have been present for one or more years before they were discovered.

The Netherlands is not the only country in which Sitka spruce is being attacked by *D. micans*. Since 1935 infestations of Sitka spruce have occurred in several places in Germany. There was one near Hohenheim, in Würtemberg, discovered in 1936 (6); then one near Giessen, discovered in 1940 (9) and finally, probably the most serious outbreak in Europe, in the northern part of Schleswig-Holstein (6).

The suddenness with which *D. micans* became a pest of Sitka spruce in Europe round about 1935 was probably due to the fact that no extensive planting of this tree took place until the end of last century, and that the trees seem to be immune from attack until they have reached a certain age. In the Netherlands this age usually varies from 35 to 40 years or more (11, 17). Observations in Germany (6, 9) seem to be in accordance with this fact. It was only round about 1935, therefore, that fairly suddenly, large numbers of trees became susceptible to attack, and the beetle could manifest itself as an important enemy of this tree.

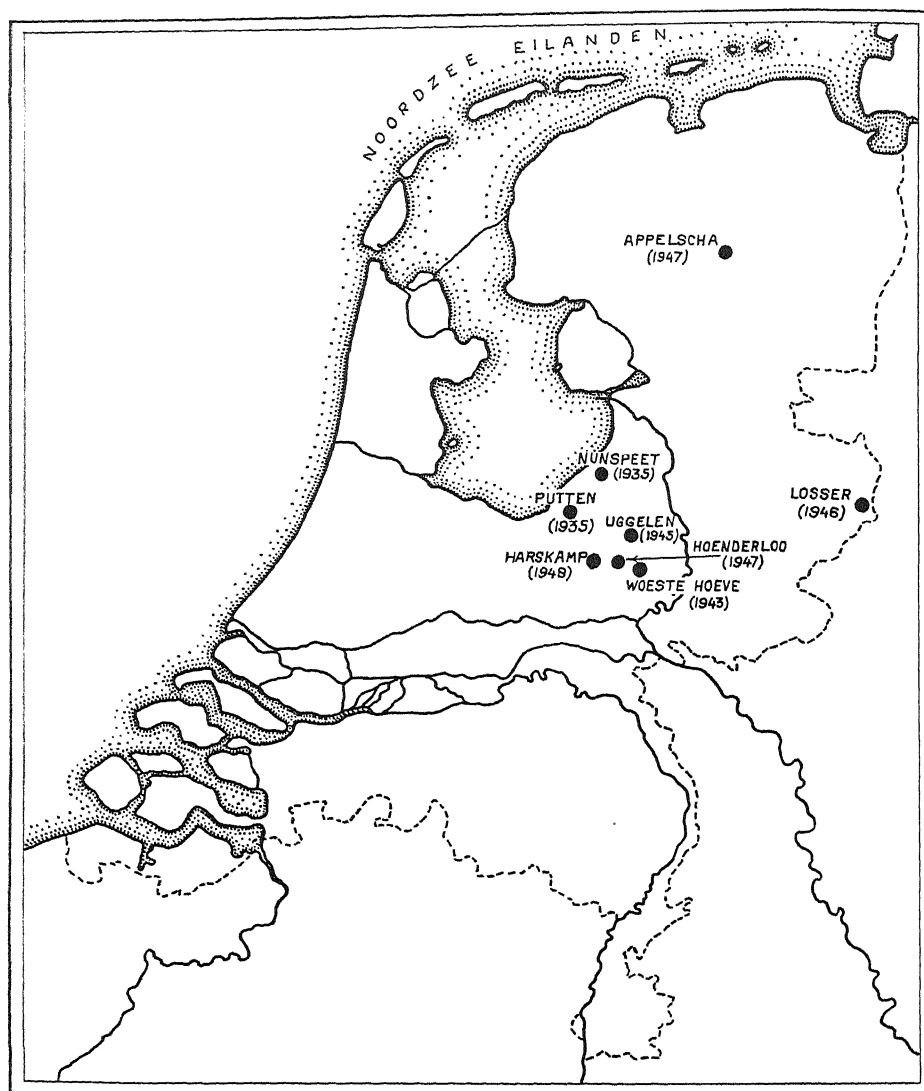


Fig. 1. The outbreaks of *Dendroctonus micans* Kugel. in the Netherlands.

As already mentioned, the original food plant of this bark beetle is Norway spruce; *Pinus silvestris* L., too, was known to be attacked (5, 8, 9). Occasional infestation of both these species has been observed in the Netherlands after the appearance of the beetle in 1935. In addition to the species so far mentioned infestations of a few other, exotic, *Picea* species have been recorded. The list of food plants recorded in the Netherlands now comprises: *Pinus silvestris* L. (a few cases, near Losser), *Picea abies* Karst, *Picea sitchensis* Carr., *Picea orientalis* Carr. (Putten, Harskamp), *Picea pungens* Engelm. (Appelscha, Harskamp), and *Picea alba* Link (Appelscha).

It is a remarkable fact that Norway spruce in the different outbreak areas are seldom seriously affected. Francke-Grosmann (6), who investigated the large outbreak in Schleswig-Holstein, also states that the beetles definitely prefer Sitka spruce to their original food plant. Observations in Holland showed that when attempts to enter Norway spruce are made, the galleries are nearly always abandoned without oviposition having taken place. Obviously, conditions in the Netherlands make the latter species unsuitable as a host plant for *D. micans*.

The most important aspect of the *Dendroctonus* problem is the question to what extent the species is a primary pest. From the various facts and opinions regarding the primary character of this beetle as an enemy of Norway spruce it may be gathered that the species, though frequently appearing as a secondary pest is quite capable of attacking perfectly healthy trees (1, 2, 3, 5, 10, 13; see also the discussion which followed the reading of Kangas' paper (7) at the VIIth Int. Congr. of Entomology in 1938). According to Francke-Grosmann (6) the same applies to Sitka spruce in Schleswig-Holstein, where *Dendroctonus* outbreaks are intimately connected with *Fomes* (*Trametes*) attack in the stands concerned. Three types of infestation could be distinguished there;

- 1) Infestation of the lower part of the trunk, including the thick portions of the larger roots, where they spring from the trunk. This type of infestation would always be preceded by infection of the roots by *Fomes annosus* Fr. (= *Trametes radiciperda* Hart.), the trees being susceptible to beetle attack only when the infection is in an early stage. As soon as the mycelium has reached the base of the tree and has penetrated into the bark there, no more attacks take place. The trees, however, die soon after this stage has been reached as a result of the combined attacks by fungus and beetles.
- 2) Infestation anywhere along the trunk of perfectly healthy trees, starting from places where the bark has been damaged (e.g. where branches have been cut off).
- 3) Infestation all along the trunk of perfectly healthy and undamaged trees. This type of infestation would only occur in severely infested areas, where the population pressure is high.

In the Netherlands a distinction was only made between infestation at the base of the tree (first type, fig. 2), presumably connected with fungus disease; and infestation all along the trunk (second and/or third type), presumably not connected with fungus infection. Investigations in this country, however, showed no constant relationship between *Fomes* infection and *Dendroctonus* attack.

In the outbreak near Putten, in the Pinetum "Schovenhorst", infestation all along the trunk predominated, and the Director of the Pinetum, Dr. Th. C. Oudemans, stated that in his opinion *Fomes annosus* had not been present in the soil anywhere near the trees.

In the outbreak near Nunspeet all types of infestation occurred promiscuously. Regarding this outbreak Dr. H. van Vloten, Director of the Forest Research Station T.N.O. at Wageningen, informed me that he found *Dendroctonus* and *Fomes annosus* in the same stand of Sitka spruce. The *Dendroctonus* infestation, however, started from the eastern side, while *Fomes annosus* killed the trees in two patches in the western part of the stand. So obviously there was no relation between the appearance of the two parasites. Regarding the outbreak near Uggelen, Dr. A. D. Voûte, Director of the "Instituut voor Toegepast Biologisch Onderzoek in de Natuur", informed me that the first type of infestation was either absent or very rare. This outbreak, there-



Foto: R. J. v. d. Linde.  
 Fig. 2. Base of the trunk of a Sitka spruce infested  
 by *Dendroctonus micans* Kugel.

fore, was probably not connected with *Fomes* infection either. In the outbreak near Lossers the first type of infestation, presumably connected with *Fomes* infection, occurred exclusively. This outbreak was also examined by Dr. H. van Vloten. The results of his observations have not been published, but permission was obtained to state here that many of the trees attacked in this way were not infected by *Fomes annosus*.

In the other outbreaks, partly of minor importance, the greater part of the affected trees showed the first type of infestation. As the absence of *Fomes* was only ascertained in a few individual trees, these outbreaks may have been initiated by the fungus. From the preceding account it will be clear, however, that in the Netherlands *Dendroctonus* outbreaks are frequently independent of fungus disease. It may, therefore, be concluded that under the conditions obtaining in this country *D. micans* usually manifests itself as a primary insect.

As regards natural control factors, it was to be expected, that the natural enemies of this bark beetle would lag behind. The two most important natural enemies are the predator *Rhizophagus grandis* Gyll. (*Nitidulidae*; 2), and the parasite *Pimpla terebrans* Rtz. (*Ichneumonidae*; 10). The former has, so far, never been found in Holland<sup>1</sup>. The latter, though present in this country, has never been found as a parasite

<sup>1</sup> Shortly after this paper was read two specimens of *Rh. grandis* were found in a *Dendroctonus* infested trunk of *Picea pungens*.

of *D. micans*. Judging by the experience of Francke-Grosman (6), however, complete suppression of outbreaks by these two species is not to be expected. Cocoons of an ichneumon parasite were found in the brood chambers of *D. micans* for the first time in July 1948. So far only one male emerged, and it was impossible to identify the species. All that can be said is that it is not *Pimpla terebrans*, the male of which has been described by Metzger (10). It is still too early to judge the importance of this species as a control factor. Other predatory species (*Thanasinus formicarius* L., *Rhizophagus ferrugineus* Payk (?)) were found in the brood chambers, but they are probably negligible as control factors. Woodpeckers too, though they are known to have opened a great number of brood chambers in one instance (Putten), on the whole seem to be of little significance.

An attempt was made by Prof. Dr. W. Roepke, of the Agricultural College, Wageningen, to introduce into the Netherlands a *Coeloides* species (*Braconidae*) parasitic on *Dendroctonus* beetles from *Pseudotsuga* in Canada. Only a comparatively small number of the species could be obtained. They were liberated in the infested stands near Putten and Nunspeet in 1937. So far, however, this parasite has never been recovered.

As to artificial control measures, the only one available was the felling of the trees, and the barking of the trunks and stumps. In most cases this measure was carried out too late or not conscientiously enough, so that the outbreaks could not be stemmed and all Sitka spruce over about 35 years of age had to be cut. In one case, where the measure was carried out with more care, the results seem to be promising, but it is as yet too early to form a definite opinion. An attempt to trap the beetles in trees of which the bark had been purposely damaged was made by Dr. A. D. Voûte. These trees, however, proved to be no more attractive than trees not so treated.

When considering the future of Sitka spruce in the Netherlands in relation to this new pest there is no reason for despair. When this tree has reached an age at which it becomes susceptible to *Dendroctonus* attack, it has already attained such a size that it can yield quite valuable timber. Then again there is a chance that the arrival of the beetle's natural enemies coupled with the finding of more effective control measures, may result in an increase in the average life-span of this tree.

An interesting question will arise in the near future, when the fairly large plantations of Sitka spruce in the dunes of the "Noordzee eilanden" (fig. 1) will become susceptible to infestation. It remains to be seen whether the beetles will be able to reach these islands, and if they do, whether it will not be possible to suppress all incipient outbreaks by constant vigilance and intensive control measures.

#### *Conclusion and summary.*

In conclusion it may be said that since its appearance in 1935 in the Netherlands *Dendroctonus micans* Kugel. usually manifests itself as a primary pest of Sitka spruce; the most effective natural enemies have not yet caught up with their host; but even if they do, complete control does not seem likely. As matters now stand, the rotation period of Sitka spruce will probably be limited by this beetle to about forty years.

#### *Acknowledgements.*

I wish to express my sincere thanks to Dr. Th. C. Oudemans, Prof. Dr. W. Roepke, Dr. A. D. Voûte, and Dr. H. van Vloten for hitherto unpublished information; to Dr. J. G. Betrem and Mr. J. Koornneef for assistance in taxonomic and faunistic

matters; and to Mrs Dr. H. Francke-Grosmann for kind permission, to refer to an unpublished report (see references).

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## LES RAVAGES DES COLÉOPTÈRES DANS LA FORÊT DE GASCOGNE

Par J. Feytaud

Parmi les faits marquants d'ordre entomologique relevés en France au cours des hostilités, il en est deux qui intéressent spécialement la région bordelaise et sa forêt de pins; c'est d'une part l'évolution grégaire de *Locusta migratoria* L., d'autre part la pullulation d'*Ips sexdentatus* Börn.

Dans la présente note consacrée au second fait, je me propose de montrer que le gros Scolytide n'est pas seul responsable des ravages subis par nos pins maritimes. S'il a joué le principal rôle, nous avons constaté, M. Hubault et moi, que d'autres Coléoptères sont intervenus pour amplifier une mortalité ayant pour cause initiale l'amoindrissement de la vigueur des arbres.

Il est en effet patent que les conditions atmosphériques des années 1942 à 1947, durant lesquelles sol et sous-sol furent progressivement asséchés par l'insuffisance des pluies, ont provoqué un état d'anémie, une déficience morbide favorisant l'emprise des insectes, surtout de ceux qui exploitent par prédilection les sujets affaiblis.

Cette sécheresse prolongée, qui affectait aussi la végétation du sous-bois, fut en outre propice aux incendies forestiers. Le feu, déclenché en de nombreux secteurs et à maintes reprises par des causes fortuites ou de déplorables négligences, quelquefois aussi par des actions malveillantes, ravagea la forêt sur de vastes étendues, laissant debout des pins mi-brûlés, dépérissants ou moribonds, excellents milieux d'élevage pour les Coléoptères en quête d'arbres sur le point de mourir.

C'est précisément à de tels sujets que s'en prend d'ordinaire *Ips sexdentatus* Börn.; mais quand il est devenu surabondant en des lieux où il ne dispose pas d'un nombre suffisant de ces hôtes choisis, il attaque aussi des arbres en bon état de santé. Il est vrai que sur les pins vigoureux l'afflux de résine dans les forages repousse bien souvent les *Ips* reproducteurs, ou les empêche et s'oppose à la poursuite de leurs tentatives.

L'extrême abondance des *sexdentatus* dans certains quartiers du Nord des Landes a déterminé, de 1944 à 1947, la formation de foyers très virulents où l'oeuvre de deux générations du gros Scolytide suffit à dévêtir les arbres de leur manteau d'écorce, après l'avoir criblé de trous de pénétration et sapé de galeries de ponte si proches les unes des autres qu'elles sont arrivées à se confondre. J'ai compté jusqu'à 13 puits d'entrée sur un décimètre carré de surface d'écorce; je ne parle pas des trous de sortie qui sont souvent bien plus nombreux.

Le développement fut plus rapide qu'il n'est indiqué dans les livres et le nombre des générations annuelles atteignit souvent 4 au lieu de 2; nous avons même noté par places l'ébauche d'une cinquième à l'état de larves au début de l'hiver.

*Ips sexdentatus* vole bien par ses moyens propres, mais ses déplacements se trouvent amplifiés par le vent qui les fait arriver parfois en ordre massif à plusieurs kilomètres du point initial et à des niveaux plus ou moins élevés au-dessus du sol, ce qui explique qu'ils entreprennent de forer leurs premiers puits en haut des troncs des vieux pins aussi bien qu'à leur base, où on les remarque mieux parce qu'ils s'y trouvent à portée du regard. Ce qui conditionne l'installation des systèmes de galeries de cet *Ips*, c'est une épaisseur suffisante du revêtement cortical; il s'installe sous les écorces rhytidomées. Ailleurs interviennent les espèces de plus petite taille: *Ips (Orthotomicus) erosus* Woll.



et *Pityogenes bidentatus* Herbst. *Ips erosus* vit fréquemment dans les parties hautes des troncs et sur des pins relativement jeunes.

C'est lui que, sous le nom de *laricis* F., Edouard Perris donnait comme "excessivement commun (en 1856) dans le département des Landes" et comme attaquant "les arbres mourants ou récemment morts de tous les âges sans se laisser rebuter par les plus gros, reculant plutôt devant les sujets très jeunes, qu'il abandonne au *bidens* (*bidentatus* F.)".

S'il creuse aussi parfois ses modestes galeries de ponte au voisinage des larges et longs couloirs du *sexdentatus*, ce n'est pas lui qui aggrave habituellement les méfaits; c'est bien davantage le *Xyleborus eurygraphus* Ratz., cet autre Ipine qui, lui, pénètre profondément dans le tissu ligneux et qui provoque la piqûre noire, cause importante de dépréciation des bois sciés. Les ravages de l'Eurygraphe se sont accrus fortement pendant et après la guerre, à la faveur des incendies, en liaison avec ceux du Sténographe.

Je note au passage l'activité accrue des *Myelophilus*, principalement du *piniperda* L., qui s'est fait remarquer en différents lieux par un élagage excessif des pointes de rameaux verts et par des envols prématurés en pleine saison d'hiver.

Il convient aux forestiers de ne pas confondre avec les *Ips* ces Hylésinines, dont la présence est plus banale, et surtout de ne pas s'alarmer, comme ils ont tendance à le faire, quand ils découvrent les troupeaux noirs du Curculionide *Rhyncolus porcatus* Germ., amateur d'aubier mort, sous les écorces décollées des pins mourants.

Ce que je veux souligner encore, c'est la remarquable poussée de multiplication manifestée par deux Coléoptères de plus grande taille : le Longicorne *Monohammus galloprovincialis* Ol., qui, à l'instar de l'Eurygraphe, compromet l'utilisation des bois sciés, et le Buprestide *Melanophila acuminata* de Geer.

Nul ne peut contester qu'Edouard Perris ait observé avec grand soin les Coléoptères de notre forêt gasconne; or s'il parle d'un Bupreste du genre *Melanophila*, "grand fléau des pins malades" âgés de plus de 15 ans, où "il pond ses oeufs en si grand nombre qu'à l'hiver l'écorce est déjà toute labourée en dessous par les galeries larges et tortueuses de ses larves", la description qu'il en donne se rapporte à *Phoenops cyanea* F. (*Melanophila tarda* F.).

Or, si ce *Phoenops* est toujours là, présent et actif comme au temps de Perris, l'espèce qui domine actuellement dans le Nord des Landes, est *Melanophila acuminata* F., bien connue à la fois dans l'Ancien et le Nouveau-Monde et réputée, comme ses congénères *ignicola* Champ. de l'Inde et *conspua* Lec. d'Amérique, pour l'attraction qu'exercent sur elle les brasiers. C'est sur des pins noircis par le feu que nous avons, M. Hubault et moi, cueilli les plus abondantes moissons de larves de cette curieuse espèce, devenue plus commune que l'autre dont elle semble avoir pris la place à la faveur des multiples et vastes incendies qui ont détruit une bonne part de notre belle forêt de pins.

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## A NOTE ON THE STATUS OF THE HOUSE LONGHORN BEETLE, *Hylotrupes bajulus* L., IN GREAT BRITAIN

By R. C. Fisher and E. C. Harris

Little accurate information is available on the status of *Hylotrupes bajulus* as a pest of softwood timbers in Great Britain, although during the period 1830—1946 there are some 40 published records of its occurrence from various parts of the country. These records, which have recently been summarized by Kaufmann (1947), are concerned chiefly with individual specimens of the beetle without reference to its habitat and, with one exception, are not related to infestation of structural timbers in buildings. Kaufmann concluded from this analysis of the literature that the "rightful status" of the insect in the British Isles "is that of a casual importation". This opinion is not shared by Hickin (1947), who suggests that such records, together with the conditions which he found in a single serious infestation in the roof of a house in Surrey, are sufficient to show that in this part of the country, it is "an established introduction".

Quite apart from the entomological interest of these records and opinions, the importance of this insect as a serious timber pest in other countries, notably in North Germany, Denmark and Sweden, demands close attention to the conditions under which it is found and its distribution in the United Kingdom, so that a true assessment of its status can be made and, at the same time, precautions taken to prevent infestation of timber in buildings. It is for this reason in particular that the Forest Products Research Laboratory maintains a record of all instances of the occurrence of the house longhorn beetle in Great Britain and makes a point of inspecting buildings in which infestation has been detected. No systematic survey of property throughout the country has been carried out, and such instances as have been examined have come to the notice of the Laboratory in the course of its normal advisory work. Yet, the information collected in this way is a most useful indication of the present economic position of the insect and points the way along which further enquiry could best be carried out.

Parkin (1934) has described the first three instances of damage examined by the Laboratory and, with the permission of Mr. F. Laing of the British Museum (Natural History), included a note on a few cases of infestation of which the latter had particulars. Briefly, these early records comprise two distinct types of infestation. In the first, severe and active attack was present in the softwood roofing timbers of a dwelling house in the county of Surrey. The origin of this infestation could not be determined and it was not ascertained whether the insect had been present in the timber, either imported or home-grown, when the building was erected about 24 years previously, or whether the attack was the result of infestation by beetles making their way into the building subsequently. In the second type of infestation, a few timbers in the roof of a church, about 100 years old, in the London area showed comparatively slight and localised attack, which had evidently long died out. Enquiry revealed that repairs had been carried out some 22 years previously. Again, however, it was not possible to determine whether the insect had been present in the original roof or whether it had been introduced at a later date in timber used for repairs.

These two types of infestation are, in general, typical of what has been found

in other cases of damage by *Hylotrupes bajulus* examined by the Laboratory during the period 1934—1948. Of some 30 records, not included in Kaufmann's paper, 8 concern old attack which had died out without causing serious structural injury to the timbers, no doubt because of the comparatively small proportion of sapwood in relation to their large dimensions. In a single instance, however, where the smaller roofing timbers in a dwelling house were affected, damage was more severe and extensive replacement was necessary, but even in this case also, no traces of living insects could be detected at the time of the inspection, possibly because of the destruction of all susceptible sapwood. These instances, located in the London area, whilst confirming that *Hylotrupes bajulus* has long occurred in this country, do not provide any more conclusive data as to the origin of the insect, although the indications are that it had been brought into the buildings concerned with the timber used at the time of their erection.

In contrast to such instances, however, increasing evidence is being obtained which supports Hickin's belief that the insect may be an established introduction in this country. There have been, within the last three years, some 15 instances at least, of severe and active attack in the roofing timbers of dwelling houses ranging from 11 to 50 years old, in a few localised areas in the south of England. These occurrences suggest that the insect may yet have to be regarded in this country as an important pest of structural timbers in comparatively new buildings. Practically all the records of active infestation have come from pine country in Surrey, and Hickin has suggested that this may be significant. In this connexion, it is of interest that in the European countries in which the house longhorn beetle is common, it has in the past not been regarded as a true forest insect breeding in trees or freshly felled timber. In South Africa, on the other hand, in parts of which it has recently caused widespread damage in roofs of buildings, Tooke and Scott (1944) record that it "has been found actively breeding in old stumps and logs in the pine forests on the slopes of Table Mountain and the Cape flats, and even in dead branches high up on living trees. It has also been found breeding in pine slab and pine pole fences". Whether such a natural habitat exists in Great Britain has not been determined but there is no doubt that in the Camberley district of Surrey there exists at present localised areas of infestation corresponding in severity to those in countries in which *Hylotrupes* has long been considered a serious pest. The full extent of the Surrey infestation is not yet known, but a local survey of buildings undertaken in 1947—1948 in the Camberley area by Mr. B. J. D. Warren, Chief Sanitary Inspector, has shown the insect to be much more widespread and the damage much more extensive than was at first anticipated. Once again, however, reliable conclusions cannot yet be drawn as to the origin and mode of spread of the attack, but the indications, more definite than hitherto, are that direct infestation from house to house has been caused by the beetles during their flight time, and not by the introduction of timber containing the larvae.

So far as is known these instances, which include the case reported by Hickin in 1947, and also examined by the Forest Products Research Laboratory, form the first records of serious infestation by the insect in Great Britain and every effort is being made to determine its full extent. Local government authorities in districts adjacent to the infested areas have been requested to keep a look-out for damage by the insect and to report any cases of infestation, or suspected infestation: in this way, an extension of the Camberley survey is now in progress. Scarcity of building timber and the resulting unavoidable use of poor quality grades with a high proportion of

sapwood, not protected by preservative treatment, have been the cause of much of the damage by the insect in other countries and may well bring about similar trouble in Great Britain. These conditions, combined with resumption of importation of building timber from the Baltic countries, where *Hylotrupes* is prevalent, are important factors which have to be taken into consideration in relation to the future status of the insect in Great Britain. In the meantime, present knowledge does not show that the insect occurs commonly throughout the country but is sufficient to emphasize the need for further investigation into its distribution and into the origin of the existing localised outbreak. A full account of the Forest Products Research Laboratory's records referred to in this brief summary of the present position will be published elsewhere in due course.

The work upon which this note is based forms part of the programme of research of the Forest Products Research Laboratory, Princes Risborough, and is published by permission of the Department of Scientific and Industrial Research.

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## ÜBER DIE EINSAMMLUNGSMETHODIK BEI UNTERSUCHUNGEN DER BODENFAUNA

Von Karl-Herman Forsslund

Während der letzten etwa 25 Jahren sind automatische Einsammlungsapparate bei quantitativen Untersuchungen über Bodenfauna in grossem Umfang benutzt worden. Die Effektivität dieser Apparate ist jedoch noch nicht genügend untersucht worden. Diese Frage ist aber für die Bodenfaunaforschung sehr wichtig, und ich habe daher einen Versuch gemacht, darüber einigermaßen zur Klarheit zu kommen. Gleichzeitig habe ich einen Vergleich zwischen zwei verschiedenen Probegrössen gemacht.

Das *Material* für die Untersuchung stammt aus einem etwas gemischten Fichtenwald in der Prov. Västerbotten in Nordschweden. In der Feldschicht dominieren hier *Vaccinium myrtillus* und *V. vitis idaea*. Die Bodenschicht besteht aus deckenden Moosen, in erster Linie *Hylocomium splendens*. Der Humustyp ist fibröser Mor (= Rohhumus), die Tiefe der Humusdecke ist 3,5—5 cm, pH za 4—5,3 in der F-Schicht, 3,8—4 in der H-Schicht.

*Methodik.* Aus einem Humusstück wurden Proben drei verschiedener Grössen ausgeschnitten: 1) 100 cm<sup>3</sup> (unten A-Proben genannt), 2) 24 cm<sup>3</sup> (B-Proben), 3) 1 cm<sup>3</sup> (C-Proben). A-Proben wurden mit grösseren, B-Proben mit kleineren Trichterapparaten behandelt. Die C-Proben wurden direkt in Glastöpfe mit Alkohol überführt und ihr Tierbestand mit Hilfe eines Präpariermikroskops herausgenommen. Von A- und B-Proben wurden je 5 Stück untersucht, von C-Proben je 5 Stück aus dem obersten Teil der Humusdecke (C 1-Proben) und 4 Stück aus ihrem untersten Teil (C 2-Proben).

Bei *quantitativem Vergleich der Proben* sind nur die Arthropoden berücksichtigt worden. Die Oribatiden sind in dick- und dünnhäutige aufgeteilt: zu den ersteren sind Imagines, zu den letzteren alle Jungformen sowie Ex. von den Gattungen *Palaeacarus* und *Brachychthonius* und auch zwei Arten der *Acaridiae* gerechnet.

Die Fauna der *A-Proben* umfasst im Mittel 15 Ex. pro cm<sup>3</sup>. Die Acariden machen etwa 71%, die Collembolen 27% aus. Die dünnhäutigen Oribatiden überwiegen über die dickhäutigen mit nur gut 1 Ex. pro cm<sup>3</sup>.

Die *B-Proben* enthalten im Mittel etwa 6 Ex. pro cm<sup>3</sup> mehr als die A-Proben. Die Acariden weisen die grösste Zunahme auf, was vor allem darauf beruht, dass kleine Trombidiiiden und dünnhäutige Oribatiden in grösseren Mengen vorkommen.

### Die totale Individuenzahl der Arthropoden pro cm<sup>3</sup>.

Probe N: r	1	2	3	4	5
Probetyp A	14,6	11,9	14,1	14,6	19,7
„ B	15,5	28,4	15,3	22,9	22,7
„ C 1	51	95	94	57	71
„ C 2	70	57	30	15	—
„ C med.	60,5	76	62	36	71

In den C-Proben (siehe Tab.) sind die Individuenzahlen bis auf eine Probe grösser als die Maximalzahlen der A- und B-Proben. Im Mittel kommen hier 58,3 Ex. pro cm<sup>3</sup> vor. Die Mittelzahl der A-Proben ist nur etwa 1/4, der B-Proben etwa 1/3 von der C-Proben, was auch so ausgedrückt werden kann, dass das Verlustprozent der A-Proben 74, der B-Proben 64 ist. Die Collembolen, die dünnhäutigen Oribatiden und die „übr-

gen Arthropoden" haben die grössten Verluste erlitten. Das Verhältnis zwischen dünn- und dickhäutigen Oribatiden ist in den C-Proben ungefähr 1:4, in den Trichterproben 1: höchstens 2.

Um ein anderes Mass für den Tierbestand als die Individuenzahl zu erhalten, wurde ein Versuch gemacht, das Volumen der Tiere zu berechnen (wegen des schnellen Austrocknens der Bodentiere ist es weniger geeignet, das Gewicht festzustellen). Zuerst wurde das Tiermaterial in verschiedene Körperformengruppen aufgeteilt. Innerhalb jeder Gruppe wurde ein Ex. mit Hilfe eines Okularmikrometers in verschiedenen Richtungen gemessen. Auf Basis der dabei erhaltenen Mass wurde dann ein stark vergrössertes Modell aus Modellierton gemacht, dessen Volumen durch Versenkung in Wasser in einem Messglas bestimmt wurde. Nachdem man die Länge der übrigen Ex. gemessen hat, kann ihr Volumen gemäss der nachstehenden Formel bestimmt werden:  $\frac{v}{l^3} \cdot l^3 = v$ , wo  $v$  1 und  $l$  1 das Volumen und die Länge des Modells,  $v$  2 und  $l$  2 das Volumen und die Länge des dem Volumen nach zu bestimmenden Exemplares bezeichnen.

Nach den Volumbestimmungen ist das durchschnittliche Verlustprozent der A- und B-Proben viel kleiner als nach den Individuenzahlen, was seine Erklärung erhält, wenn man das Mittelvolumen der Tierexemplare betrachtet. Dieses Volumen steigt mit zunehmender Probegrösse. Daraus dürfte hervorgehen, dass vor allem die kleinen Tierformen bei der Behandlung mit Trichterapparaten zugrunde gehen und daher in den diesbezüglichen Proben stark unterrepräsentiert werden. Daneben ist es selbstverständlich von Bedeutung, dass die grösseren Proben mehr grosse Tiere als die kleineren enthalten können.

Bei *qualitativem Vergleich der Proben* habe ich wegen Schwierigkeiten der Bestimmung nur die Gamasiden, Oribatiden (inkl. 2 *Acaridiae*-Arten) und Collembolen verglichen. Von diesen Gruppen sind 68 Arten angetroffen worden, von denen 47 Arten den Probetypen A und B gemeinsam sind. Die A-Proben enthalten im Mittel 37,8, die B-Probe 27,4 Arten pro Probe. Die Arten, die nur in einer der Probetypen vorkommen, treten jedoch akzidentell und vereinzelt auf und spielen daher keine Rolle für die Charakterisierung der Fauna. — Die C-Proben sind selbstverständlich zu klein für eine qualitative Beurteilung. Die C 1-Proben haben im Mittel 12,2, die C 2-Proben 8 Arten pro Probe.

Für 22 Arten ist die Konstanz dieselbe in den A- und den B-Proben. Die übrigen Arten sind meistens etwas konstanter in A als in B, aber gewöhnlich nicht viel, so dass man sagen kann, dass mehr als 90 % der Arten ungefähr dieselbe Konstanz in den beiden Probetypen haben.

In sämtlichen Proben gehören 50 Arten den zwei niedrigsten Abundanzgruppen an, sie kommen also vereinzelt bis spärlich vor und sind niemals dominierend. Die übrigen sind dominierend in wenigstens einer oder einigen Proben. Von besonderem Interesse sind folgende 5 Arten: *Brachychthonius simplex* Forssl., *Oppia neerlandica* Oud., *Willemia anophthalma* Börn., *Onychiurus affinis* Ägren und *Isotoma minor* Schöff. Sie sind die individuenreichsten Arten mit 100 % Konstanz sowohl in A als in B und sind dominierend in sämtlichen Proben.

Aus dem Gesagten dürfte hervorgehen, dass die kleineren B-Proben ein ebenso gutes Bild von der Zusammensetzung der Fauna geben wie die grösseren A-Proben. Betreffs der Abundanz geben sie sogar ein besseres Resultat.

Auch in den kleinen C-Proben nehmen die in den A- und B-Proben individuenreichsten Arten die ersten Plätze ein. Die Abundanz ist hier aber viel höher als in A und B. Zweifellos beruht dies darauf, dass sehr viele Tiere beim Austrocknen der Proben in den Trichterapparaten getötet werden. Die Resistenz der meisten Bodentiere gegen niedrige Luftfeuchtigkeit ist oft sehr gering, was z. B. Agrell für die Collembolen gezeigt hat.

*Der Trichter als Fehlerquelle.* Nicht alle Tiere, die durch das Sieb der Trichterapparate fallen, gelangen in die Spiritusschale. Ziemlich viele bleiben an der Innenseite des Trichters sitzen. Dies gilt vor allem von den Trombidiiden und den dünnhäutigen Oribatiden. In den A-Trichtern blieben von den ersteren gut 20 %, von den letzteren gut 30 %, in den B-Trichtern aber viel weniger. Man kann diese Tiere z. B. durch vorsichtiges Fegen mit einer Hühnerfeder in die Schale bringen.

*Die Auslesezeit* der A-Proben war in diesem Falle ein Tag länger als die der B-Proben. Die Temperatur war während der Versuchszeit 15,3—18°, die relative Luftfeuchtigkeit 52,8—68 %.

*Schlusswort.* Es dürfte klar sein, dass man bei Bodenfaunauntersuchungen mit Hilfe der Trichterapparate keine zuverlässigen quantitativen Resultate erhält. Diese Methode muss daher durch andere Methoden, die sich nicht auf das Austrocknungsprinzip gründen, ergänzt werden, um so mehr als man auch andere Tiere (Würmer, Rotatorien u. a.) als die Gliedertiere berücksichtigen muss. Welche Methoden hierbei die geeignetsten sind, muss experimentell untersucht werden. Das ist für die Bodenfaunaforschung eine sehr dringende Aufgabe.

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## DIE GEFÄHRDUNG DER SITKAFICHTE DURCH ROTFÄULE (*Fomes annosus* Fr.) UND RIESENBASTKÄFER (*Dendroctonus micans* Kug.) IN AUFFORSTUNGSREVIEREN SCHLESWIGS

Von *Helene Francke-Grosmann*

Der Riesenbastkäfer ist seit etwa 15 Jahren in Europa an der Sitkafichte beobachtet worden, und zwar zuerst in Holland, südlich der Zuidersee, fast gleichzeitig in einem Versuchsrevier der württembergischen Forstlichen Versuchsanstalt Hohenheim und später auch im Giessener Forstgarten. Alle von *Dendroctonus*-befall betroffenen Bestände waren etwa 40 Jahre alt, und der Befall fand vorwiegend an der Stammbasis statt.

Während es sich bei den genannten Vorkommen des Riesenbastkäfers an der Sitkafichte nur um kleinere, örtlich begrenzte Befallsherde handelt, tritt der Riesenbastkäfer in Schleswig-Holstein an verschiedenen Fichtenarten, vorzugsweise jedoch an der Sitkafichte auf grosser Fläche auf. Der Befall übertrifft bei weitem die beim Angriff der heimischen Fichte üblichen Ausmasse und hat stellenweise beunruhigende Formen angenommen. Er erstreckt sich zur Zeit über das gesamte Geestgebiet des mittleren Schleswig-Holsteins und reicht von der dänischen Grenze bis nach Hamburg. Die letzte Meldung stammt aus der Revierförsterei Kummerfeld bei Pinneberg.

Am schwersten von der Kalamität betroffen sind die durch Forstrat *K. Emeis* ab 1880 gegründeten Acker- und Ödlandaufforstungsflächen des Reviers Langenberg, das in dem sich zwischen Flensburg und Apenrade hinziehenden Sandergebiete nahe der dänischen Grenze gelegen ist. Hier hatte der Käfer stellenweise bis zu 80 % der angepflanzten Fichten — neben der Sitkafichte auch die heimische Rotfichte und die Weissfichte — befallen. Aber auch anderorts, wie in dem kleinen „Jähdehain“ in Schobüll bei Husum, einem nur 40 ha grossen, hart am Wattenmeer auf einer Moränescholle gelegenen, aus einer Ackeraufforstung hervorgegangenen Bestand, tritt der Käfer verheerend auf. Auch auf der Insel Föhr, etwa 30 km vom Festlande entfernt, konnte der Käfer in Sitkafichte gefunden werden.

Die genannten Acker- und Ödlandflächen waren ursprünglich bewaldet. Seit dem Mittelalter ist die Entwaldung weit fortgeschritten, und die Folge war die Entstehung von ausgedehnten Heide- und Moorflächen, die allen Versuchen, sie mit heimischen Holzarten aufzuforsten, lange widerstanden haben. Erst *K. Emeis* gelang es, diese Flächen unter Verwendung der verschiedensten in- und ausländischen Nadelhölzer, — oft unter Voranbau der Bergkiefer zur Eindämmung des Heidekrautes, wie es in Dänemark erprobt worden war, — wieder einer geordneten Waldwirtschaft zuzuführen.

Zunächst hatte sich dabei die Sitkafichte gerade auf den ärmeren Standorten bestens bewährt. Diese aus Nordamerika stammende, humides Seeklima liebende, sturmefeste, raschwüchsige und genügsame Holzart schien für die genannten Standorte bestens geeignet zu sein und wurde daher auch in grösserem Umfange verwendet. Noch heute, nachdem bereits der Rückgang der Sitkafichte sich sehr bemerkbar macht und grössere Flächen eingeschlagen werden mussten, beträgt der Sitkafichtenanteil in den zum Forstbezirk Langenberg gehörigen Revierteilen Süderlügum und Karlum nach Schätzung von Herrn Forstmeister *Wagner*, Flensburg, noch etwa 25 %. Da nach dem Vorbild der *Emeis'schen* Aufforstungen in der Folge eine grosse Anzahl von Beständen



in Schleswig-Holstein gegründet worden ist, ist die Sitkafichte hier eine sehr verbreitete Holzart.

Der Rückgang der Sitkafichte in Südschleswig datiert etwa von dem Jahre 1930 an. Wie W. Emeis, der Sohn und Nachfolger des Gründers der Bestände von Langenberg mitteilt, zeigten sich schon damals einzelne, durch *Fomes annosus* absterbende Sitkafichten, und wenige Jahre später trat auch der Riesenbastkäfer auf.

Es war nun das Ziel der vorliegenden Untersuchungen, die durch Beratung aus den Abteilungen Bodenkunde, Botanik und Waldbau gefördert und ergänzt wurden, festzustellen, welche Umstände die Übervermehrung des Riesenbastkäfers an der Sitkafichte begünstigt haben, und daraus zu folgern, ob der Nachbau der Sitkafichte, dieser für die genannten Lagen so wertvollen Holzart, noch zu empfehlen sei.

Drei Eigenschaften der Sitkafichte sind es, welche den *Dendroctonus*-Befall begünstigen, weil sie dem Käfer willkommene Brutlegenheiten schaffen:

Einmal hat die Sitkafichte die unangenehme Eigenschaft, sehr astig zu erwachsen, sowie sie Raum dazu hat. Da sie auf den ärmeren Böden vorwüchsig ist, legt sie sich hier stark in die Seitenäste, wenn sie in Einzelmischung mit anderen Holzarten angebaut wird. Ähnlich ist es im weit gegründeten Reinbestand. Da sie sich nicht selbst reinigt, muss sie mit der Axt aufgeastet werden, was in dem waldarmen Landstrich oft in Selbstwerbung zur Brennholzgewinnung geschieht und nicht immer sachgemäss ausgeführt wird. So entstehen Wunden, die später gern vom Käfer befallen werden (Abb. 1). Ebenso nachteilig wirkt sich die oft unrechtmässig betriebene Gewinnung von Schmuckreisig aus, die bereits bei jüngeren Bäumen schwere Wunden verursachen kann.

Eine andere ungünstige Eigenschaft der Sitkafichte ist ihre Neigung zu Zwieselbildung, die in Schleswig-Holstein besonders in sturmgefährdeten Lagen beobachtet werden kann, aber vielleicht auch mit der in der Jugend hohen Empfindlichkeit der Sitkafichte gegen Spätfröste zusammenhängt. Der Käfer brütet hier nicht nur in den Stümpfen zu spät gekappter Zwiesel, sondern auch in der Verwachsungsnähe lebender Zwiesel und in den Innenflächen der Zwillingsstämme (Abb. 2).

Am schwerwiegendsten ist aber die Tatsache, dass die Sitkafichte im Alter von 35—40 Jahren unter den gegebenen Verhältnissen ausserordentlich anfällig gegen *Fomes annosus* wird, insbesondere, wenn es sich um trockenere Standorte bei Acker- und Ödlandaufforstungen handelt (Abb. 3 u. 4). In Dänemark ist diese Erscheinung bereits früher beobachtet worden und ist hier von *Løfting* eingehend untersucht worden. Die Sitkafichte reagiert auf den Fomesbefall anders als die Rotfichte. Während ältere heimische Fichten den Befall durch den Pilz lange Zeit ertragen können und die Fäule bereits mehrere Meter im Stamm heraufgestiegen sein kann, ehe sich Krankheitserscheinungen äusserlich bemerkbar machen, reagiert die Sitkafichte schon auf die Infektion einer einzigen Hauptwurzel mit Nadelverlusten und „Harzsticken“, d. h. dem spontanen Austritt von Harztröpfchen aus der Stammrinde. Der Baum pflegt abzusterben, noch ehe die Fäule die unteren Stammpartien ergriffen hat.

Nach erfolgtem Harzsticken wird der Baum zur Brut für den Käfer geeignet, welcher zuerst die infizierte Seite des Stammes befällt, meist genau oberhalb der erkrankten Wurzeln, und zwar ausschliesslich an den unteren Stamnteilen und den Wurzelanläufen. Die charakteristischen „Harztrichter“ finden sich dabei in ganz bezeichnender Weise besonders gehäuft an der Berührungslinie des Stammes mit der Oberfläche des Waldbodens, und der Befall reicht tief in die unter der Streuschicht gelegenen Rindenteile hinab. Da der Rotfäuleanteil stellenweise recht erheblich sein kann, — er kann nach den Ergebnissen von Stubbenrodungen in etwa 40jährigen Beständen bis zu 85 %

betragen —, findet der Riesenbastkäfer in den Aufforstungsrevieren Brutgelegheiten in Hülle und Fülle (Abb. 5).

Dass der Käfer gelegentlich auch in rotfaulen heimischen Fichten brütet, ist eine bekannte Tatsache, aber noch nie hat sich diese biologische Beziehung zu Wurzelpilzen so katastrophal ausgewirkt wie bei den Sitkafichten der Aufforstungsflächen Schleswigs. Hier sind die Voraussetzungen für das Auftreten von *Fomes annosus* durch Reinanbau fomesgefährdeter Holzarten auf grösseren Flächen sowie durch Voranbau der Bergkiefer, deren Stubben mit Sicherheit rotfaul werden und so Infektionsmöglichkeiten bieten, besonders gegeben, und vielleicht bewirkt die andere Reaktionsweise der Sitkafichte auf den Pilzbefall, dass fomeskranke Sitkafichten häufiger vom Käfer angenommen werden als fomeskranke heimische Rotfichten.

Selbstverständlich brütet der Riesenbastkäfer daneben auch bei der Sitkafichte in der Nähe von Verwundungen anderer Art, an Fällungs- und Rückschäden, in gekappten oberflächlichen Wurzeln, an Blitzzissen und anderen Verletzungen. Es scheint dabei ausschlaggebend zu sein, dass der Saftstrom zwischen Krone und Wurzel unterbrochen ist, wodurch besondere physiologische Verhältnisse geschaffen werden. Auch bei Wurzeln, die infolge von *Fomes* absterben, ist dieses der Fall, wie auch an den einander zugekehrten Rindenteilen der Zwieselstämme.

Die Sitkafichte reagiert auf den *Dendroctonus*-Befall mit ausserordentlich starkem Harzfluss, sodass die bekannten Harztrichter, an denen das Vorhandensein des Riesenbastkäfers bereits äusserlich sichtbar ist, ganz erhebliche Ausmasse annehmen und die Harzmassen oft den Umfang eines kleinen Hühnereis besitzen. Sie sind so auffällig, dass sie in den am schwersten betroffenen Gegenden von aufmerksamen Hausfrauen zum Feueranzünden gesammelt werden.

Es erscheint nun zunächst erstaunlich, dass ein Borkenkäfer einen so starken Harzfluss ertragen kann, ohne davon abgeschreckt oder getötet zu werden. Es scheint jedoch so, als ob die Schutzwirkung des Harzes beim Riesenbastkäfer völlig versagt. Der Grund dazu liegt zweifellos in der Grösse und Stärke dieses Käfers, der mit 7—9 mm Länge unser grösster heimischer Borkenkäfer überhaupt ist.

Der Käfer umschliesst mit seinen Elytren einen geräumigen Atemraum; er kann die Luft unter den Flügeldecken, wie der Gelbrandkäfer, von der Hinterseite her erneuern. Taucht man einen Käfer in flüssiges Harz, so zeigen sich zunächst am Hinterende einige Luftbläschen, und der Käfer bemüht sich sofort, durch schabende Bewegungen des Abdomens gegen die Elytren sich den durch Harz verklebten Atemraum wieder zu eröffnen. Wenn ihm dies nicht gleich gelingt, so nimmt er auch noch die Hinterbeine zu Hilfe, um das sich über der Atemöffnung am Körperende bildende Harzhäutchen zu zerreißen. Obwohl die Käfer bei der Arbeit des Herausschaffens des mit Bohrmehl untermischten Harzes aus ihren Gängen mitunter ganz von Harz überkrustet und bei der Überwinterung direkt in Harzklumpen eingebohrt sind, konnte doch kein nachweislich im Harz erstickter Käfer aufgefunden werden.

Diese Unempfindlichkeit des Käfers gegen Harz befähigt ihn zu ausserordentlich „primären“ Befall seiner Brutpflanzen. Der Käfer dringt dabei in die völlig unverletzte Rinde gesunder Fichten ein, kommt aber nicht zur Brut, sondern nagt einen mehr oder weniger langen, oft bis zu 20 cm und länger werdenden Gang, der äusserlich durch einen besonders grossen oder durch eine Reihe von kleineren Harztrichtern gekennzeichnet ist, und der in der Regel etwa senkrecht zur Faserrichtung verläuft und den Stamm partiell geradezu „ringelt“ (Abb. 6). Der Käfer verlässt diesen Gang wieder, der nun aber den Stamm zur Brut für den Käfer geeignet gemacht hat. Oberhalb und

unterhalb dieser „Ringelung“ wird der Stamm aufs Neue befallen, und diese erneuten Angriffe führen zur Brut. Auf diese Weise werden in den Zentren der Kalamität gesunde Sitkafichten befallen, oft bis in die Kronenregion hinein (Abb. 7).

Auch die Larven sind zu einem Leben in harzreicher Umgebung befähigt. Sie besitzen Stigmen, die von geräumigen Hautfalten, den Stigmenkammern, überlagert sind, in welchen sie einen Vorrat von Atemluft führen (Abb. 8). Der Zugang zu dem Stigma, die *Porta atrii*, ist ausserordentlich klein, sie misst im Durchmesser nur etwa 10  $\mu$ , sodass infolge von Oberflächenspannungen Flüssigkeiten schwer eindringen können. Der eigentliche Stigmenmund ist in die Tiefe verlagert. Im Harz umgekommene Larven konnten nicht gefunden werden, jedoch wird überwinterten Larven im Frühjahr der aufsteigende Saftstrom gelegentlich zum Verhängnis, und es konnten Anfang Mai mitunter jüngere Larven im 2. oder 3. Entwicklungsstadium ertrunken aufgefunden werden.

Obwohl die Sitkafichtenrinde sich durch ihren enormen Harzreichtum von der Rotfichte unterscheidet und obwohl sie auch beträchtlich härter ist als diese, finden offensichtlich die Larven des Riesenbastkäfers in der Sitkafichte beste Ernährungsbedingungen vor. Die in Sitkafichte erwachsenen Exemplare des Riesenbastkäfers sind meist auffallend gut genährt, der Fettkörper ist gut entwickelt, und ihre Körpermasse bewegen sich an der oberen Grenze. In Abb. 9 ist eine Kurve dargestellt, die sich auf je 30 gemessene weibliche Käfer aus Sitka-(S) und Rotfichte (R) bezieht. Die Tiere stammten aus einem kleinen Bestand im Stangenholzalter, die befallenen Stämme hatten 12–13 cm Durchmesser. Der Grössenunterschied, der hier allerdings ganz besonders krass ist, ist deutlich erkennbar. Es ist sicher, dass die grossen, gut genährten Exemplare um so besser mit dem Harzfluss der Sitkafichte fertig werden, es hat sich also hier geradezu eine Wechselwirkung herausgebildet, ja es scheint so, als ob sich eine biologische Rasse des Riesenbastkäfers an der Sitkafichte herausbilden wollte. Käfer, die in Sitkafichte erwachsen sind, nehmen im Zuchtversuch nur zögernd die gebotene Rotfichtenrinde an, und ein viel geringerer Prozentsatz der Tiere kommt zur Anlage einer Brut als diejenigen Käfer, die aus Rotfichtenrinde stammten. Umgekehrt brüteten aus Rotfichte stammende *Dendroctonus*-♀♀ in verhältnismässig hohem Prozentsatz auch in abgelöster Sitkafichtenrinde, obwohl sie, wenn beides geboten wurde, die gewohnte Rinde bevorzugten.

Die Reproduktionskraft dieser wohlgenährten♀♀ ist bedeutend grösser als die der kleineren, was besonders verständlich wird, wenn man bedenkt, dass ein 9 mm langes etwa doppelt so schwer ist wie ein 7 mm langes. Während die 9 mm grossen♀♀ Eigelege von 80–90 Stück im Zuchtexperiment erzielten, legten die kleineren, etwa 7,5 mm grossen nur etwa 50–60 Eier. Das ist schon ein epidemiologisch stark ins Gewicht fallender Unterschied.

Weiter leisten die grossen Käfer ihrem Hauptfeind, dem kleinen Nitiduliden *Rhizophagus grandis* Gyll. viel stärkeren Widerstand als die kleineren Exemplare. *Rhizophagus*, der nach Bergmiller entscheidend an der Beendigung einer *Dendroctonus*-Kalamität beteiligt sein kann, scheint an der Sitkafichte nicht recht zur Geltung zu kommen. Offensichtlich wird er durch den starken Harzfluss dieser Holzart empfindlich gestört, denn er findet sich meist erst in älteren Bruten ein. Ungünstig mag sich auch für ihn auswirken, dass hier die Pilzflora, insbesondere die Borkenkäferfrass regelmässig begleitende Bläueflora nur schwach entwickelt ist und so seinen Larven und auch dem Käfer die „Notnahrung“ fehlt. Besonders wirksam ist *Rhizophagus* im Winter, wo er die überwinterten Jungkäfer dezimiert. Diese sind bei kühleren Temperaturen ausserordentlich träge, während der weniger wärmebedürftige *Rhizophagus* noch recht

aktiv ist. In den Frassstellen in Sitkafichte scheint sich *Rhizophagus* vorwiegend an die kleineren und daher schwächeren ♂♂ zu halten. Während im Herbst das Geschlechtsverhältnis etwa 1:5 beträgt, findet man gerade in der Sitkafichte im Frühjahr bei den überwinterten Jungkäfern ein auffallend weites Geschlechtsverhältnis vor, das sich im Durchschnitt auf etwa 1:20 beläuft — das weiteste war 1:48 —, während die in Rotfichte erwachsenen überwinterten Riesenbastkäfer ein deutlich engeres Geschlechtsverhältnis aufweisen. Hier scheinen auch die ♀♀ dem kleinen Räuber zum Opfer zu fallen, der die Käfer gern an einer dünnhäutigen Stelle zwischen dem 1. und 2. Sternit oder auch an den weichen Tergiten unter den Flügeldecken anfrisst (Abb. 10). Der Verlust einer grösseren Anzahl von ♂♂ ist jedoch bei *Dendroctonus* ziemlich belanglos, da die Käfer bereits an ihrer Geburtsstätte befruchtet werden, und zwar oftmals schon im Herbst, und weil die ♂♂, die einen stark entwickelten Genitalapparat besitzen ausserordentlich polygam sind. Da eine einmalige Befruchtung für eine ganze Brut, oft noch für eine kleinere Nachbrut, ausreicht, und die Spermien den Winter lebend überdauern können, besteht kaum die Gefahr, dass ein ♀ unbefruchtet bleibt, auch wenn das Geschlechtsverhältnis ein  $\pm$  weites ist.

Sehr wesentlich scheint bei Befall wurzelkranker Sitkafichten auch folgender Umstand zu sein: Der Riesenbastkäfer hat die Gewohnheit, vom alten Frassbild aus die angrenzende noch frische Rinde zu befallen und im Anschluss an die alte Frassstelle zu brüten. Im allgemeinen dauert solch ein Befall mehrere Jahre, bis der Rindenmantel soweit zerstört ist, dass der Baum eingeht. Dieses Verhalten hat zwar biologische Vorteile für den Käfer, aber noch mehr Nachteile. Der Käfer umgeht zwar das Ausschwärmen, das ihn in Gefahr bringen könnte, von Vögeln und anderen Feinden gefressen zu werden, er legt dafür aber eine Brut an, die mit der alten, von allerhand tierischen Feinden des Riesenbastkäfers bevölkerten Frassstelle in offener Verbindung steht. Da diese Feinde leicht in das junge Frassbild eindringen können, ist die Brut erhöht gefährdet. Ferner kommen, wenn eine grössere Anzahl von Feinden nicht vorhanden ist, die heranwachsenden Larven mitunter arg ins Gedränge, kann es doch vorkommen, dass auf einer Länge von ca. 20 cm am Rande der alten Frassstelle 8 neue Bruten angelegt werden. Die Larven fressen dann so dicht gedrängt, dass es gar nicht mehr zur Ausbildung einer regulären „Bohrmehlplatte“ kommt, viele Larven werden dauernd von der Futterstelle abgedrängt und gehen zu hunderten an Entkräftung ein. Schliesslich fehlt den Larven, denen es trotzdem gelungen ist, ihre Entwicklung zu vollenden, die schützende Bohrmehlplatte zur Verpuppung und den Jungkäfern die Jugendnahrung.

Zum Verlust der Bohrmehlplatte kann es auch kommen, wenn sich die Bruten der einen Stammseite aus kleinklimatischen Gründen schneller entwickeln als die der anderen. Es kann dann geschehen, dass in der einen Brutstätte bereits fertige Käfer vorhanden sind, während sich in einer anderen noch Puppen vorfinden. Die Jungkäfer dringen gern in die Frassstelle der zurückgebliebenen Brut ein, zerstören die Bohrmehlplatte und vernichten gleichzeitig die Puppen.

Bei Befall von fomeskranken Sitkafichten lässt sich feststellen, dass hier der Riesenbastkäfer nur ein, höchstens zwei Jahre lang brütet. Mit fortschreitender Erkrankung der Sitkafichte wird die Rinde zur Brut für die Käfer untauglich, und alle wandern aus, noch ehe die Schadstelle die sonst üblichen Ausmasse erreicht hat. Der Brutstamm wird also vorzeitig verlassen, die Käfer suchen Brutgelegenheiten in der Nachbarschaft und befallen neue Stämme zu „sekundärer“ Brut oder zu „primären“ Probeeinstichen. An der neuen Brutstätte kann sich die Brut besser entwickeln als an dem alten Brutbaum, und der Primärangriff bereitet einen neuen Stamm für spätere Brut vor.

Gerade in diesen Primärangriffen liegt, waldbaulich gesehen, die Gefahr der *Dendroctonus*-übervermehrung, da durch diese auch völlig gesunde Sitka- und Rotfichten, bis hinab zu Stärken von 5 cm Durchmesser, gefährdet werden können (vergl. Abb. 3 und 4).

Das Problem des Sitkafichtenrückganges in Schleswig-Holstein ist also ein ausserordentlich vielseitiges, bei welchem die Anfälligkeit der Sitkafichte gegen *Fomes annosus*, die etwa vom 35. Lebensjahre an in Erscheinung tritt, sowie das Auftreten des Riesenbastkäfers eine hervorragende Rolle spielen. Bei der weiteren waldbaulichen Behandlung gefährdeter Bestände und bei Neuaufforstungen von Acker- und Ödland muss also in Zukunft nach Möglichkeit alles vermieden werden, was die Ausbreitung der Rotfäule und die Vermehrung des Riesenbastkäfers begünstigt.

Der Weiteranbau der Sitkafichte auf den besonders gefährdeten trockeneren und ärmeren Standorten der genannten Aufforstungsflächen wird im allgemein besonders wünschenswert sein, da sie gerade dort Massenleistungen hervorbringt wie keine andere Holzart. Sie wird hier jetzt in kleineren, dicht gegründeten Horsten eingebracht, wo sie feinastig und zwieselfrei erwachsen kann und wo bei späterem Ausfall keine waldbaulichen Schwierigkeiten entstehen. Es ist zweifellos ein gewisses Risiko, die Sitkafichte auf den verseuchten Böden nachzubauen, und Løfting warnt vor dieser Massnahme, jedoch ist es durchaus richtig, diesen Versuch mit der wertvollen Sitkafichte, über welche diesbezüglich noch keine Erfahrungen vorliegen, zu unternehmen. Die jungen, vor 5 Jahren angelegten Horste sind bis jetzt ausserordentlich wuchsfreudig und gesund geblieben.

Jedenfalls muss aber der Anbau der Sitkafichte in den gefährdeten Lagen unter besonderer Vorsicht vor sich gehen, und die Bestände müssen mit Aufmerksamkeit beobachtet werden. Sie müssen eingeschlagen werden, sobald sich die Rotfäule bemerkbar macht, um einer Übervermehrung des Riesenbastkäfers, der auch die noch gesunden jüngeren Sitkafichten, sowie die Rotfichten gefährden würde, vorzubeugen. Da das im kritischen Alter von 35—40 Jahren geschieht, wo die Sitkafichte bereits nutzbar ist, ist den frühe Einschlag auch wirtschaftlich vertretbar.

Es soll daneben versucht werden, durch Nachzucht von Überhältern aus Sterbelücken, die sich zunächst als resistent erwiesen haben, eine Sitkafichtenrasse mit längerer Lebensdauer heranzuzüchten und so die in fomes-gefährdeten Lagen ausserordentlich kurze Umtriebszeit zu verlängern.

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# BESCHRIFTUNG DER ABBILDUNGEN

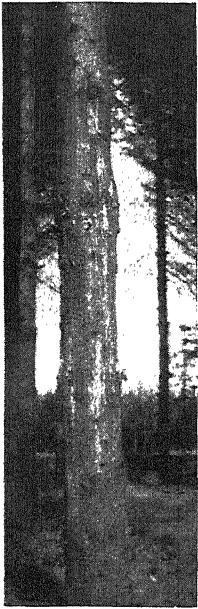


Abbildung 1. *Dendroctonus*befall, von Astungswunden ausgehend.

Abbildung 2. Befall an Sitkafichtenzwiesel.

Abbildung 3. Sterbelücke in 38jährigem Sitkafichtenbestand mit *Dendroctonus*befall. Der Käfer brütet bereits „primär“ in dem im Hintergrund sichtbaren Stangenholz.



Abbildung 4. Sterbelücke mit Käferbefall in 38jährigem Sitkafichtenbestand. Schobüll, Westrand. Auch die Nachbesserung rechts ist vom Käfer befallen.

Abbildung 5. *Dendroctonus*befall an der Basis einer fomeskranken Sitkafichte mit „*U. piceae*“

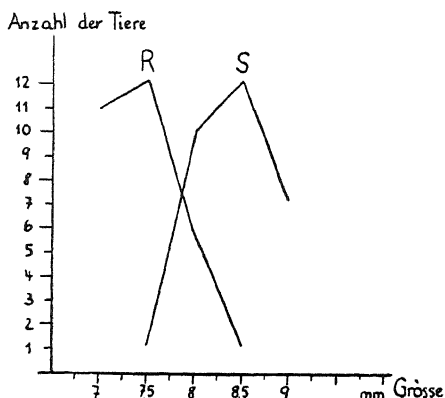
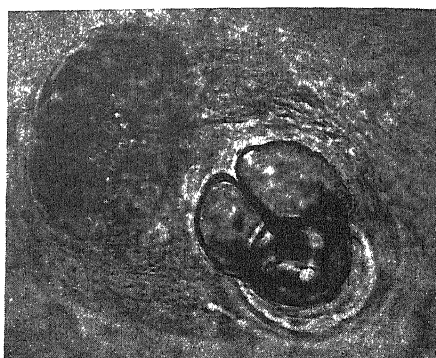
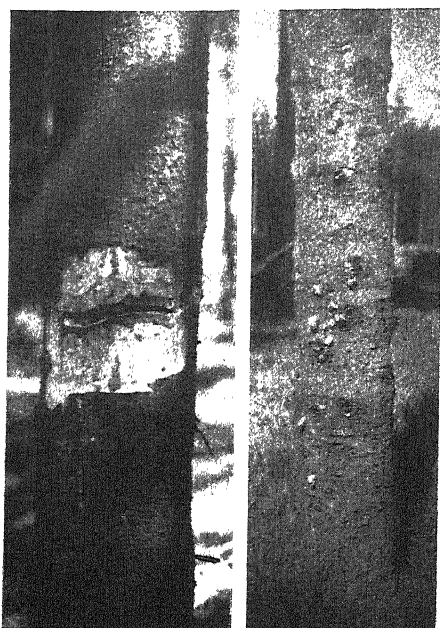


Abbildung 6. Primärer „Probeeinstich“ an junger Sitkafichte. Der Gang ist vom Käfer verlassen, das umgebende Gewebe gebräunt.

Abbildung 7. Primärer Befall an einer gesunden Rotfichte in einem Käferherd in Schobüll.

Abbildung 8. Larvenstigma von *Dendroctonus*.

Abbildung 9. Grössenverhältnisse zweier *Dendroctonus*-Bruten aus Rot- (R) und Sitkafichte (S).

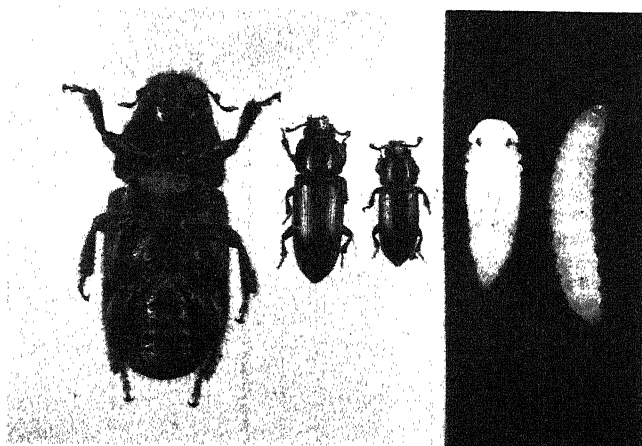


Abbildung 10. *Dendroctonus* und sein Feind *Rhizophagus grandis*. *Dendroctonus* ventral, die Angriffsstelle zwischen 1. und 2. Sternit ist zu sehen. *Rhizophagus* ♀, ♂, Puppe und Larve.

## BEITRÄGE ZUR KENNTNIS DER VERBREITUNG UND BIOLOGIE VON *Cossus terebra*

Von J. S. Grönvall

Ich bitte etwas über die Verbreitung und Biologie des *Cossus terebra*, speziell in Finnland, berichten zu dürfen. Die Landkarte veranschaulicht die jetzt bekannte Verbreitung dieser Art in Europa laut Nordmans Zusammenstellung in Notulae Entomologicae 1940, und meiner späteren Beobachtungen: (Fig. 1)

Gemäss den Handbüchern kommt *Cossus terebra* überall äusserst selten und dann nur lokal vor. Im Osten hat man ihn in ganz Sibirien bis Amur, und im Süden in Armenien und Iran festgestellt. In Europa soll er am häufigsten in den Donau-Ländern, in Süd-Tirol und in der Schweiz, sowie um den Wolga-Fluss herum vorkommen. In den nordischen Ländern, ausser Finnland, ist mir nur ein Fundort bekannt, Uppsala

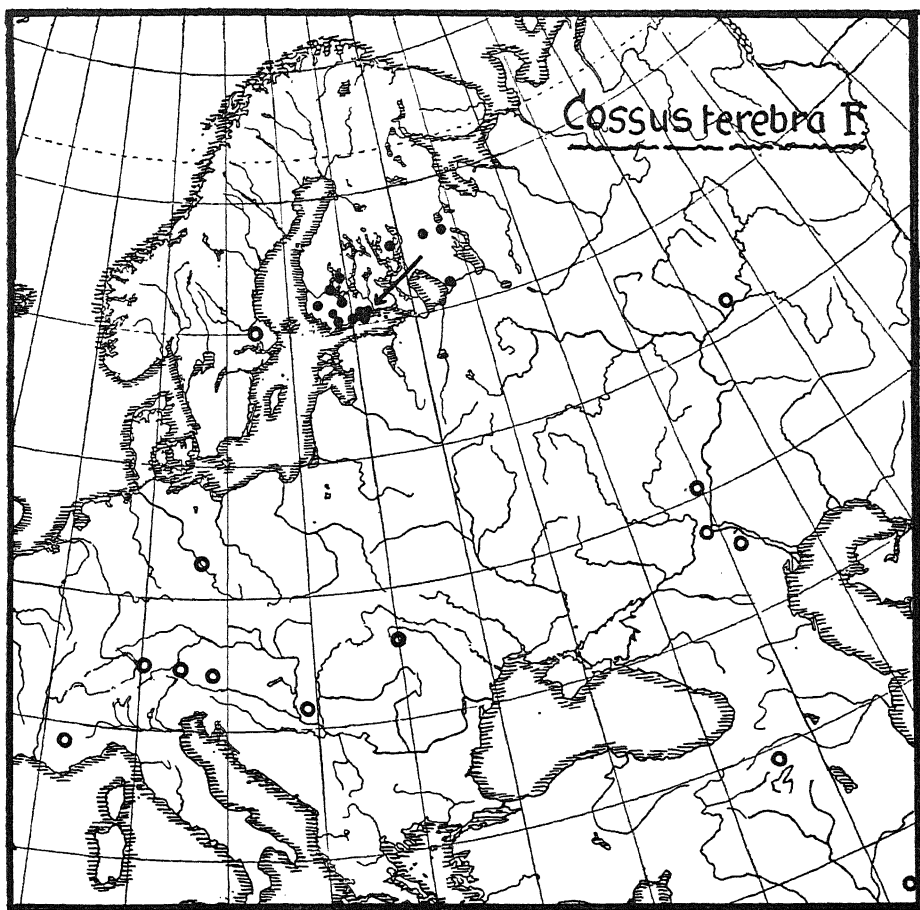


Fig. 1.



in Schweden. Der erste Fund in Nord-Europa wurde im Jahre 1857 in Finnland, in Yläne in der Nähe der Stadt Åbo, von dem Berliner Kretschmar gemacht. (2 St. Imago) Die späteren Fundorte sind nach Nordman neun, sämtlich in Süd- und Mittel-Finnland. 1920 i Lojo, Håkan Lindberg (Puppenschalen). 1923 in Pirkkala, T. Grönblom (Puppenschalen). 1932 in Hattula, A. Wegelius, (Imago). 1939 in Sammatti, H. Krogerus (Vorderflügel). 1939 in Helsing, S. Stockmann (Puppen). 1940, 46, 47, und 48 in Borgå, Seitlax, und Weckjärvi, A. Nordman, H. Ahlqvist (Imago, Larven und Puppenschalen). Hierzu kommen meine eigenen Funde 1940, 41, 42 und 46 in Liljendal, zwanzig Kilometer nördlich der Stadt Lovisa. Fig. 2 zeigt einige Exemplare

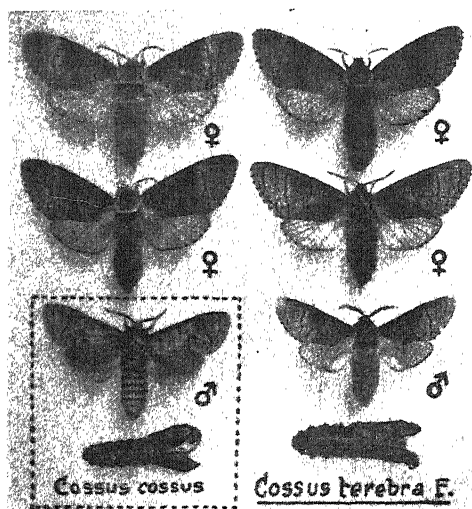


Fig. 2.

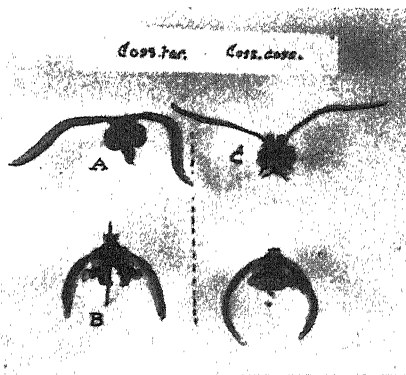


Fig. 3.

von meinem Material und zum Vergleich einen *Cossus cossus* Männchen. Die Flügelbreite meiner normalen Weibchen beträgt 77 bis 80 Millimeter, also kaum weniger als bei *Cossus cossus*, bei den Männchen 66 m.m. Dagegen sind die Weibchen, die in halbtrockenem Holz gelebt haben, ebenso klein wie die Männchen. Die stahlgraue Farbe des *Cossus terebra* ist rein auch auf dem Hinterkörper. Ältere befettete Exemplare gehen etwas in gelb über. Das Graue bei *Cossus cossus* nähert sich dem Braun. Auch die hellen Hinterflügel des *terebra* sind sehr typisch. Gute Kennzeichen der Männchen von *Cossus terebra* sind die doppelreihigen Kammantennen mit circa 150 Fransen (Fig. 3 A). *Cossus cossus* hat dagegen nur 60 Fransen in einer Reihe (Fig. 3 C). Die drei Stirnstacheln der Puppe des *Cossus terebra* sowie ihre kräftigen Stacheln an den Hinterkörpersegmenten sind ebenfalls augenfällig (Fig. 3 B). Hier sehen wir die hellsten und dunkelsten der in Liljendal gefundenen Weibchen (Fig. 4).

Dieser Fund wurde in einer 19 Meter hohen, am Boden einer halben Meter dicken Espe gemacht, die in einer sonnigen Lichtung im Mischwald wuchs. Der Baum war anscheinend eine längere Zeit von *Cossus terebra* Larven bewohnt gewesen.

Nach dem ich zwei Jahre (im August) zu spät zu dieser Stelle kam und nur leere Puppenschalen vorfand, kaufte ich den Baum und fällte ihn am 7. Juni 1942. Bei

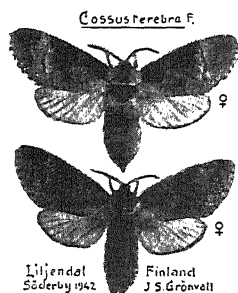


Fig. 4.

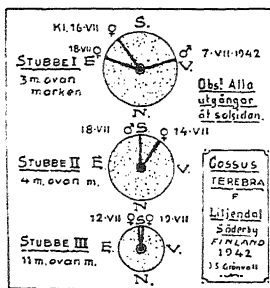


Fig. 5.

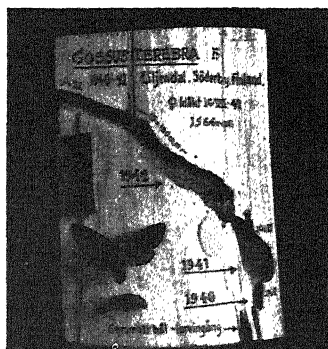


Fig. 6.

Entfernung der Rinde kamen am Stamm 7 Ausgangsöffnungen von Larven in drei verschiedenen Gruppen zum Vorschein, die erste in 3 Meter, die zweite in 4 Meter und die dritte in 11 Meter Höhe (Fig. 5). Aus den Baumstümpfen wurden während der Zeit vom 7. bis 19. Juli 5 Weibchen, sowie 2 Männchen ausgebrütet. Von einem der halbtrockenen Baumstümpfe kamen im folgenden Jahr 2 kleine Weibchen hervor. In demselben Jahr fand man auch in dem zurückgelassenen Holz in Liljendal 6 leere Puppenschalen. In demselben Stamm wurden also im Ganzen 15 Stück *Cossus terebra* ausgebrütet. In einer alten, trocknen Espe in der Nähe befanden sich 12 *Cossus terebra* Löcher, die jetzt von Ameisen bewohnt waren. Dieses deutet darauf hin, dass *Cossus terebra* kein Neukömling an diesem Orte ist. Dass die Art durch den Fang im Jahre 1942 nicht ausgerottet wurde, beweist ein Larvenfund in halbtrockenem Espenholz im Jahre 1946. Durch diesen Fund erhielt ich auch ein kleines Weibchen. Der Schnitt (Fig. 6), zeigt die Folgen einer dreijährigen Tätigkeit der Larve des *Cossus terebra* im Holze. Durch ein altes Loch sind die neu-ausgekrochenen Larven eingebrochen und haben ihr erstes Winterneut im Jahre 1940 genagt. 1941 ist das Nest viel grösser. 1942 hat die circa 15 Millimeter dicke Larve in der Zeit vom März bis Juni ihren Ausgang und ihre Verpuppungshöhle angefertigt, in der letzteren mit nur kleinen Spänen und der Larvenhaut als Unterlage. Zu berücksichtigen ist, dass *Cossus terebra* keinen Kokong hat wie *Cossus cossus*, welcher sich bekanntlich in einem starken Kokong in der Erde verpuppt.

Einen ausgesägten Decken habe ich in der zurückgelassenen, äusserst dünnen Rindenschicht nicht gefunden. Doch war ein durchgefressenes Loch, das mit Spänen und Saliv verklebt worden war, bei mehreren Ausfahrten vorhanden. Durch das Loch hat die Larve wahrscheinlich Späne ausgeschoben.

Das Ausbrüten geschieht in der Ausgangsöffnung, wo die Puppenschale, zur Hälfte herausragend, zurückbleibt. Den bekannten *Cossus*-Geruch habe ich bei *terebra* nicht bemerkt.

Ein bemerkenswerter Umstand ist der Winkel oder die Krümmung, die sämtliche Ausgänge aufweisen (Fig. 6). Wahrscheinlich soll sie es verhindern, dass die Zunge der Spechte tiefer in den Gang eindringt. Durch Experimente am Zoologischen Museum zeigte es sich, dass die Puppe, die sich gerne in der Nähe der Ausgangsöffnung aufhielt, beim Klopfen am Stamm sich hastig zur hinteren Wand des Ganges zurückzog.

Bezüglich der Eierlegung bin ich der Ansicht, dass das Weibchen die Eier in alte Löcher und Ritze alter Baumstämme legt. Falls die Eier auf dem Boden gelegt würden, wie Nordman annimmt, kann ich schwer verstehen, wie die kleinen Larven an ein und derselben Stelle hinein kommen können, oft in grosser Höhe und Gruppen bildend. Was die Farbe der jungen Larven anbelangt, verweise ich auf die ausführliche Beschreibung von Nordman in Notulae. Die von mir angetroffenen erwachsenen Larven waren milchweiss mit dunkelbraunem Kopf.

Die früher wenig bekannte Entwicklung des *Cossus terebra* hat sicherlich dazu beigetragen, dass er oft übersehen und dann als äusserst selten angenommen wurde. Die in Finnland gemachten Beobachtungen lassen jedoch vermuten, und neue Untersuchungen werden es wahrscheinlich bestätigen, dass diese Art weiter verbreitet und allgemeiner ist, als man bisher angenommen hat.

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## ERFAHRUNGEN BEI DER BEKÄMPFUNG DES Hausbocks (*Hylotrupes bajulus*) IN NORDWESTDEUTSCHLAND

Von R. Hespeler

Der Hausbock-käfer der seine Eier heute fast ausschliesslich in verbautes — totes — Holz legt, und dessen Larven dieses von innen heraus zerfressen, ist heute wohl der gefährlichste aller Holzschädlinge. Die Gefahr die das Auftreten dieses Tieres für den Bestand der Gebäude und damit für einen ganz grossen Teil des Volksvermögens bildet, wurde in Deutschland schon vor etwa 20 Jahren über die rein wissenschaftliche Forschung hinaus bekannt. Darauf setzten planmässige Untersuchungen ganzer Landesteile ein, durch die festgestellt wurde, dass ein hoher Prozentsatz aller Gebäude mit Holzdachstühlen mehr oder minder stark von dem Hausbock befallen war. In einzelnen Gebieten wurde sogar ein Befall bis zu 90 % aller Häuser ermittelt. Wenn auch bei der überwiegenden Zahl aller Gebäude sich die Zerstörungen in mässigen Grenzen hielten, so war doch bei einer erschreckend grossen Zahl von Häusern die Zerstörungen so gross, dass viele tragende Hölzer völlig zerfressen waren und dadurch die Standfestigkeit ganzer Dachstühle und Häuser gefährdet war. Man konnte einwandfrei feststellen, dass der Schädling sich immer mehr ausbreitet, aus Gründen, die hier im kurzen Rahmen dieses Vortrags nicht erörtert werden können.

Die Gefahr liegt beim Hausbock — im Gegensatz zu vielen andern Schädlingen wie Schwamm, Bohrwurm, Fäulnis u. s. w. bekanntlich darin, dass die Hausbocklarven wie etwa die tropischen Termiten jahrelang im Innern des Holzes ihr Zerstörungswerk verrichten, ohne dass man von aussen etwas davon sieht. Erst wenn der aus der Larve etnsschlüpfte Käfer die Aussen-haut des Holzes durchnagt um auszufliegen, erkennt man ihn an dem eigenartigen ovalen Flugloch, das 3—5 mm breit und 5—10 mm lang wird. Dann ist aber oft unter völlig unversehrter Oberfläche das Innere des Holzes so zerstört, dass es nicht mehr tragfähig ist und ein grosser Aufwand von Geld und Holz nötig wird, um die Standfestigkeit des Holzes wiederherzustellen.

Als man in Norddeutschland vor etwa 20 Jahren die grösseren Schadenfälle wissenschaftlich und planmässig technisch untersuchte, waren dies natürlich nicht die ersten Zerstörungen dieses Tieres. Aber vorher war doch wohl die Ausbreitung geringer, und im Übrigen nahm man eben diese Zerstörungen wie Blitzschlag, Schwamm und Fäulnis als Tatsachen hin, die man grundsätzlich nicht vermeiden konnte. Wenn ein Dach, oder ein ganzer Holzbau eben vom „Holzwurm“ wie man allgemein sagte zerfressen war, wurde das schadhafte Holz eben ersetzt. Holz gab es ja vor 1914 genug in Deutschland zu kaufen, den Begriff „Mangelware“ kannte man überhaupt nicht und mit den Kosten war es in der wirtschaftlich guten Zeit auch nicht so schlimm.

Nach dem ersten Weltkrieg jedoch war Holz und Geld schon sehr knapp und man hatte alle Ursache der Sache mehr auf den Grund zu gehen und Vorbeugung wie Abhilfe zu erwägen. Man stellte einwandfrei fest, dass die grossen Schäden auf den Hausbock — (*Hylotrupes bajulus*) — zurückzuführen sind. Der Kampf richtete sich also gegen diesen Feind, da die Schäden der anderen Holzschädlinge an und in Gebäuden nicht entfernt an die Schäden heranreichen, die der Hausbock anrichtet. Die ersten Bekämpfungen grösseren Masstabs an Gebäuden, mit gründlicher Nachprüfung aller Auswirkungen, wurden in Hamburg, Lübeck und Kiel vorgenommen. Die Bekämpfungs-

arbeit gab auch Gelegenheit viele Lebensgewohnheiten des Tieres, Zerstörungsvorgänge, Befallstärken, Widerstandsfähigkeit u. s. w. kennen zu lernen. Sehr unterstützt wurde die praktische Arbeit durch die voraufgegangene und gleichlaufende Tätigkeit deutscher und ausländischer Wissenschaftler. In praktischer Beziehung gaben aber auch die Bekämpfungsarbeiten in Dänemark und die Untersuchungen des Technologischen Instituts in Kopenhagen sehr wertvolle Anregungen.

Die Landesbrandkassen Deutschlands stellten grosse Mittel für Aufnahmearbeiten zur Verfügung, durch die man erst genauere Aufschlüsse über die umfangreiche Ausbreitung des Schädlings gewann und die biologische Reichsanstalt in Kiel sowie das Materialprüfungsamt Berlin-Dahlem führten laufend wissenschaftliche Untersuchungen durch, die sich sehr bald darauf ausdehnten die, bald nach den ersten grösseren Bekämpfungsarbeiten in den Handel kommenden, vielen Mittel kritisch zu untersuchen und zu vermeiden, dass Geld für wertlose oder nur gering wirkende Mittel ausgegeben wird.

Ich will hier auf diese Arbeiten nicht eingehen, sondern nur über die Erfahrungen bei der praktischen Bekämpfung berichten. Dabei muss natürlich erwähnt werden dass zu der Zeit wo keine Kriegs- und Nachkriegshindernisse vorhanden waren, beide Teile: Wissenschaft und Praxis, miteinander arbeiteten, sich gegenseitig ergänzten, und die beiderseitigen Erfahrungen austauschten.

Die Weiterführung dieser Arbeiten ist aber heute in Deutschland besonders wichtig, weil sich gezeigt hat, dass durch die in den letzten 10 Jahren fast ganz ausgefallene Bekämpfung, der Schädling sich stark weiter ausgebreitet hat, und eine Gefahr bildet, die grösser ist denn je. Dazu kommt dass Holz heute bei uns zu den allergrössten Mangelwaren gehört und man alles daransetzen sollte, das Holz des durch Krieg und Kriegsfolgen so furchtbar zusammengeschrunpften Wohnraumes so stark als möglich vor Verderben zu schützen.

Wie bei allen Krankheiten ist aber auch hier die *frühzeitige Erkenntnis* des Schadens die erste Grundlage für die Verhinderung der Ausbreitung und für die Heilung selbst. Durch Aufklärung aller Art wurde daher versucht sowohl den privaten Hausbesitz wie die Behörden zu bewegen, immer wieder das Holz in ihren Häusern, vor allem aber ihre Dachstühle zu untersuchen um festzustellen, ob Anzeichen vorhanden sind, dass das Tier im Hause ist. Viele Leute meinen, erst dann sei Gefahr vorhanden, wenn man wirkliche Zerstörungen sieht, oder mindestens Bohrmehl auf dem Boden liegt. Aber gerade kleine Bohrmehlhäufchen können von dem viel weniger gefährlichen kleinen Bohrwurm stammen, also völlig unbedenklich sein, während wenige Fluglöcher Anlass zu genaueren Untersuchungen geben und dann mit Schrecken wahrgenommen wird, wie tief schon „der Wurm im Gebälk sitzt“. Selbst wo keine Fluglöcher sichtbar sind, kann Befall vorhanden sein. Man sollte alles Holzwerk mit Messern untersuchen, ob unter der unversehrten Oberfläche weiche Stellen sitzen. Findet man solche, schneidet man den oberen gesunden Streifen ab, sieht dann einen mit feinstem Holzmehl gefüllten Frassgang und weiss nun dass der Dachstuhl angefressen ist. Besonders sorgsam sollte man das Holzwerk in der Nähe der Dachfenster untersuchen, da dort neben den Einflugsmöglichkeiten der Käfer die meisten Ansteckungsstellen liegen. Die grösseren Zerstörungen finden sich meist in den weichen Holzteilen und knapp unter der Oberfläche, aber bei schwerem Befall ist das Holz bis auf den Kern oder die harten Rippen der Jahresringe zerfressen. Ich habe sogar Fälle gesehen, wo erst durch den Bruch eines Balkens der Besitzer auf die Anwesenheit dieses bösen Hausgastes aufmerksam wurde. Hier half nur noch ein halber Hausabbruch wenn man aber rechtzeitig eingreift, kann man das Tier vernichten ehe es allzugrossen Schaden anrichtet. Dies muss

aber unbedingt angestrebt werden, denn je stärker der Befall, desto schwieriger wird die völlige Heilung.

Feststellungen eines Schadensherdes können aber auch schon zur *Vorbeugung* benutzt werden. Fluglöcher zeigen, dass Tiere ausgeflogen sind; wo einige Fluglöcher sind, ist anzunehmen, dass weitere neu entstehen, denn ein einziger Käfer legt durchschnittlich 40—60 Eier. Es können also immer noch weitere Käfer ausfliegen und ihre Eier im gleichen Haus legen, oder durch die Dachfenster abfliegen und andere Häuser mit ihrer Nachkommenschaft beglücken. Das Umherfliegen im gleichen Hause kann man bei unbetäubten Käfern nicht verhindern, wohl aber das Ausfliegen, wenn man an den Dachfenstern eines befallenen Hauses Fliegengitter anbringt. Aber man kann in gewissem Rahmen auch das Neu-Belegen im eigenen Hause verhindern. Die Ausflugzeit ist ja in den heissen Sommermonaten. Hat man in einem Hause Befall festgestellt, sucht man täglich den Boden ab, ob man Käfer findet. Meist kriechen die neu ausgeschlüpften Käfer noch etwas herum, ehe sie auf Braut- oder Bräutigamsschau ziehen. In dieser Zeit können sie leicht beseitigt werden.

Die Vorbeugung muss sich aber auch auf Häuser ausdehnen, die noch nicht befallen sind. Als einfachste Vorbeugungsmassnahme hat sich auch hier das Anbringen vorgenannter Fliegengitter bewährt. Sie verhindern den Einflug, aber gestatten die Durchlüftung des Raumes. Die Anbringung ist vor Allem für Dachböden gedacht, denn diese sind am meisten gefährdet, weil sie meist viel unverputztes trockenes rissiges Holz besitzen, in das das Hausbockweibchen mit Vorliebe seine Eier legt. Ein Einflug in Wohnräume mit wenig und meist gut angestrichenem Holz ist viel seltener. Natürlich finden sich auch dort Einflüge und Eierablage selbst in Schränken, aber dort ist eine Bekämpfung auch viel leichter als in einem grossen Bodenraum. Bei Neubauten und bei Einbau von neuem Holz in alten Häusern sollte man unbedingt das Holz auf Hausbockbefall untersuchen, besonders genau dann, wenn man altes Holz verwendet. Wenn auch der Hausbock nicht aus dem Wald mit neuem Holz eingeschleppt wird, so kann es doch auf Holzplätzen mit Hausbockbefall versehen werden, was ich öfters festgestellt habe als man annehmen sollte. Es sind hierdurch auch schon recht unangenehme Schadensersatzklagen entstanden.

Es ist deshalb sehr zu empfehlen, alles neu zu verbauende Holz mit einem geeigneten Schutzanstrich oder einer entsprechenden Tränkung mit einem als wirksam erprobten Vorbeugungsmittel zu versehen. Besonders die Kopfenden und Verbindungsstellen an die man später gar nicht mehr herankommt sind besonders gründlich zu behandeln. Unverarbeitetes Holz ist natürlich viel wirksamer und einfacher zu behandeln als ein fertiger Dachstuhl. Man wendet hier die Arbeitsmethoden des Tränkens und Tauchens mit an, mit denen man bei Eisenbahnschwellen, Telegrafmasten u. s. w. gute Erfahrungen gemacht hat. Es ist aber dabei zu beachten dass ein gutes Fäulnisschutzmittel nicht einfach auch gegen Hausbock Schutz bietet und muss ein Mittel verwenden das diese Eigenschaft nachgewiesen hat.

Wenn man mit einem solch erprobten Vorbeugungsmittel gegen Hausbockbefall alte Dachstühle behandeln will, so wendet man wenn möglich statt Anstrich Spritzung an. Mit der Spritze kommt man an Stellen die man nur sehr schlecht mit einem Pinsel gut bedecken kann. Die Kosten solcher Vorbeugung sind zwar nicht unerheblich, aber doch noch sehr billig im Verhältnis zu den Kosten, die die Behandlung eines bereits befallenen Dachstuhles verschlingt.

Wo die Voruntersuchung zeigte, dass bereits Befall vorhanden ist, kann man nicht mehr vorbeugen sondern muss: *Bekämpfen*.

Während beim Vorbeugen es sich nur darum handelt, dass die Hausböcke das Holz nicht angreifen, gilt es beim Bekämpfen die bereits im Holz sitzenden Larven zu töten, einen Wiederbefall zu verhindern, und gleichzeitig das zerfressene Holzwerk so zu verstärken und zu ersetzen, dass der Bau wieder seine volle Standfähigkeit erhält.

Gleichgültig, welche der einzelnen Bekämpfungsmethoden man dann anwendet, man sollte auf alle Fälle vorher sorgfältig die zerstörten Teile des Holzes zimmermannsmässig entfernen. Es wird wohl bei einigen Methoden angegeben dass dies nicht nötig sei, ich bin aber hier anderer Ansicht. Das Holzmehl in den Bohrgängen bietet gegen jedes Bekämpfungsmittel einen guten Schutz und je mehr man davon wegnimmt desto besser kommt das Mittel an die Tiere heran. Aber man soll auch nur die wirklich zerstörten Teile wegnehmen und darf keineswegs gesundes Holz bis zum letzten einzeln ins Holzzinnere führenden Frassgang abschlagen. Solche Gänge kann man am ihrem Ausgang noch etwas anschlitzten, kann sie aber sonst ruhig lassen. Alles noch auf dem gesunden Holz ruhende Holzmehl muss mit einer scharfen Bürste aus Draht entfernt werden. Zeigt sich nach Abschluss der Arbeit, dass einige Hölzer recht dünn geworden sind, so muss statisch berechnet werden, ob sie noch halten, ob sie verstärkt oder ersetzt werden müssen. Genügt eine Verstärkung, so muss man mit der Axt eine glatte Anschlussfläche herstellen, damit das daran anzubringende Verstärkungsstück auch wirklich mit dem alten Holz zusammen wirkt. Vor Anbringung des neuen Holzes müssen aber die Verbindungsstellen tief mit einem Bekämpfungsmittel behandelt werden. Nun erst geht es an die Bekämpfung der noch in den inneren Frassgängen sitzenden Larven. Meist holt man ja bei Entfernung der zerstörten Teile schon Käfer, Puppen und Larven heraus, aber gerade weil man zur Holzersparnis nicht alles Befallene abschlagen kann, bleiben noch reichlich Larven im Holze sitzen. Für deren Tötung kann man die in Dänemark sehr viel angewandte Heissluftbehandlung, die Vergasung und die Holztränkung mit chemischen Abtötungsmitteln verwenden. In Deutschland hat sich, zum Teil natürlich auch aus den Zeitbedingungen heraus, die Letztere als die geeignetste und wirkungsvollste erwiesen. Die Heissluftbehandlung, die ja auch ziemlich umfangreiche Maschinen- und Rohranlagen und nach der Abtötung zweckmässig noch einen Vorbeugungsanstrich erfordert, scheidet heute in Deutschland wegen der Kohlenknappheit aus.

Die Vergasung ist in Westdeutschland wo jedes Haus mit Menschen überfüllt ist bei Wohn- und Geschäftsgebäuden ausgeschlossen, da das zu behandelnde Haus tagelang von Menschen, Tieren und Lebensmitteln geräumt werden muss. Im Frieden haben wir sie bei Schulgebäuden in den Ferien mit Erfolg angewandt, aber es musste auch ein Vorbeugungsanstrich und eine Nachbehandlung erfolgen.

Dagegen haben wir mit der in grossem Massstabe angewandten Spritzung oder dem Anstrich mit chemischen Bekämpfungsmitteln gute Erfolge erzielt. Dieses Verfahren ist ohne grösseren Apparat überall anwendbar, die Arbeit hat aber nur dann Zweck, wenn ein als wirksam erprobtes Abtötungsmittel sorgfältig und sachgerecht angewandt wird. Das Mittel muss zweckmässig als Berührungs-Frass und Atemgift wirken, damit auch Tiere erfasst werden, die nicht unmittelbar von der Flüssigkeit berührt werden. Die Eindringungstiefe jeder Flüssigkeit ist ja beschränkt, und die Tiere sitzen teilweise sehr tief im Innern des Holzes.

Es ist nicht angebracht in diesem kleinen Vortrag, der die praktischen Arbeiten erläutern soll, die wissenschaftlichen Untersuchungen über Eigenschaften und chemische Zusammensetzung der einzelnen Mittel zu behandeln. Ich verweise hier u. A. auf die

Arbeiten von Professor Dr. Schulze und Dr. Becker vom Materialprüfungsamt in Berlin-Dahlem.

In der Praxis ist in hohem Maasse, mit sehr gutem Ergebnis, Xylamon verwendet worden neben Barol, Fluralsil, Wolman-Salzen und Anderen. Die neueren Untersuchungen führten zu einem als sehr günstig erprobten Mittel dem Osmol WB<sub>4</sub>. Das Aufzählen der Mittel ist keineswegs erschöpfend, denn die Einzelbeurteilung würde allein einen grossen Vortrag bedeuten; aber es kann nicht genug davor gewarnt werden, Mittel zu verwenden, lediglich auf unbewiesene Empfehlungen von Verkäufern hin. Man sollte sich in jedem Falle durch amtliche oder sonst anerkannte Prüfungsberichte bestätigen lassen, dass das Mittel wirklich sich für die Hausbockbekämpfung eignet, und ob es als Vorbeugungsmittel, als Berührungs-, Frass- oder Atemgift anzusprechen ist, oder ob es alle diese Eigenschaften in sich vereinigt.

Wie schon bei der Vorbeugung erwähnt, erfolgt das Aufbringen der chemischen Bekämpfungsmittel am Besten durch Spritzen. Nach meinen Erfahrungen sollte man immer einen zweimaligen Auftrag ausführen, damit man auch wirklich die Sicherheit hat, eine völlige Überdeckung der Holzoberfläche auch in den Ritzen und Spalten zu bekommen und ein möglichst tiefes Eindringen der aufgetragenen Flüssigkeit in das Holz zu erreichen. Gerade das Erfassen der Ritzen und Spalten ist wichtig, denn dadurch kommt der Giftstoff weit in das Innere des Holzes hinein. Als Abtötungsmittel kommen so die Flüssigkeit und die von ihr ausgehenden Gase näher an die tief innen sitzenden Larven heran als dies bei einem reinen Oberflächenanstrich möglich wäre. Als Vorbeugung werden aber gerade die Stellen geschützt, in die das Hausbockweibchen vermittelst seiner Legeröhre mit Vorliebe seine Eier legt.

Besonders schwer zugängliche Stellen kann man durch die Bohrlochimpfung behandeln. Diese kommt z. B. in Anwendung wenn man Balkenlagen schützen will, die nur gefährdet oder ganz wenig angegangen sind, besonders wenn man den Fussboden nicht aufnehmen will oder kann. In diesem Falle bohrt man durch den Fussboden Löcher und füllt diese mit dem Bekämpfungsmittel. Es breitet sich dann vom Loch aus in das Innere des Holzes aus. Man kann hier so lange nachfüllen, bis das Holz keine Flüssigkeit mehr aufnimmt, dann ist die ganze Umgebung des Bohrloches getränkt. Wir haben früher zwischen die Balkenfache eine Auffüllmasse gelegt, die mit Xylamon getränkt war. In dem wieder abgeschlossenen Raume sollten dann die sich entwickelnden Gase als Atemgift wirken und in die umliegenden Balken, Latten, Einschub- und Fussbodenbretter eindringen. Bei einer späteren Nachprüfung wurden zwar tote Käfer und Larven, also auch eine Wirkung festgestellt, aber es waren auch noch Anzeichen vorhanden, dass noch lebendige Larven im Holz blieben. Diese letzten Reste wurden dann wieder durch Bohrlochimpfung abgetötet.

Mehrere Mittel haben einen scharfen Geruch. Das ursprüngliche Xylamon war daher trotz seiner guten Eigenschaften bei vielen Hausbesitzern nicht gerne gesehen, denn Dachböden die damit behandelt wurden, rochen teilweise Monate lang und teilten ihren Geruch auch der dort aufgehängten Wäsche mit. Die Herstellerfirma brachte darauf ein erheblich geruchswächeres Xylamon in den Handel das bei guter Wirkung diese Nachteile vermied. Völlig geruchsfrei ist es allerdings auch nicht, ebensowenig wie das Osmol WB<sub>4</sub>; aber dieser Geruch ist zu ertragen. Man kann im Übrigen durch Verschliessen des Bodens wenigstens verhüten, dass der Geruch durch das Haus zieht. Irgendwelche gesundheitliche Schäden hat m. W. auch der stärkste Xylamongeruch nicht verursacht; ein Brennen der Augen bei langem Aufenthalt im Behandlungsraum ist eine vorübergehende Erscheinung.



Bei allen Bekämpfungsarbeiten haben wir die Erfahrung gemacht, dass — gleichgültig um welches Mittel es sich handelt — eine restlose Abtötung aller Tiere meist beim ersten Male nicht möglich ist. Es bleiben immer einige tief innen sitzende Larven und Käfer übrig, an die das Bekämpfungsmittel nicht herangekommen ist. Diese fressen dann unentwegt weiter, aber bei den schon ausgewachsenen Larven hat man den Eindruck dass sie fluchtartig den ungemütlich gewordenen Platz verlassen. Die sich zu Käfern entwickelnden Larven sind in ihrer Puppenwiege fast gegen alle Mittel geschützt, die Käfer schlüpfen oft auch nach der Bekämpfung aus und fressen sich selbst durch stark getränkte Oberflächen durch. Aber wenn sie herauskommen sind sie fast immer betäubt oder vergiftet, so dass sie kaum fliegen können. Man sieht gerade in den Wochen nach der Behandlung viele Käfer auf dem Fussboden liegen und es ist nötig dass man jeden Tag nachsieht und sie aufsammelt, denn bei der Zähigkeit dieser Insekten ist es nicht ausgeschlossen, dass sie sich wieder erholen.

Die weiter im Holzinne lebenden Larven fressen in den von Tränkung und Gaswirkung unberührten Holzteilen ruhig weiter (denn auch bei gründlicher Spritzung dringt bei stärkerem Holz die Wirkung nicht bis zum Kern durch). Wenn sie aber an behandelte Stellen kommen, gehen sie weit überwiegend ein. Aber es gibt auch hier besonders widerstandsfähige Exemplare, die sich hinter der getränkten Schicht ihre Puppenwiege bauen und dann 1—2 Jahre später erst ausschlüpfen. Man kann aber ihr Wirken schon vorher durch Abhören feststellen. Bei etwas Erfahrung kann man ziemlich genau ihren Sitz ermitteln und bohrt dann ein Loch nach der Richtung der ermittelten Lage. Dies füllt man mit dem Bekämpfungsmittel und kann dann das Tier mit ziemlicher Sicherheit abtöten.

Wenn noch lebende Tiere nach einer ersten Behandlung bemerkbar sind, so ist dies kein Beweis ihrer Zwecklosigkeit. Wir haben in verschiedenen Fälle durch Zerkleinerung von Probestücken festgestellt, dass durch die erste Arbeit etwa 80—97 % aller mutmasslich im Holze vorhanden gewesener Tiere getötet wurden. Dies ist ein so grosser Erfolg, dass man die Nachbehandlung ruhig mit in Kauf nehmen kann.

Am wirksamsten ist es, wenn nach Feststellung eines Schadensherdes gleichzeitig die Bekämpfung eines ganzen Stadtgebietes erfolgt. Um eine einheitliche Durchführung zu ermöglichen und die Kosten zu verteilen, wurden in Hamburg und Lübeck vor dem Kriege staatliche Umlagen auf den Hausbesitz erhoben und aus deren Aufkommen die Bekämpfung bezahlt. Die Brandversicherungsanstalten gaben weiter darüberhinaus noch Zuschüsse, weil Hausbockzerstörungen eine wesentlich höhere Gefährdung des Hauses gegen Feuer bedeuten. Private Hausbockversicherungen wie sie mit so grossem Erfolg in Dänemark arbeiten, sind in Deutschland m. W. bisher nirgends entstanden.

Die Bekämpfungserfahrungen zeigen deutlich, wie schwer es ist, ein vom Hausbock befallenes Haus von diesem zu befreien und den von ihm angerichteten Schaden zu heilen. Die Wiederherstellung angefressener und stark beschädigter Häuser kommt fast einem Neubau gleich. Das benötigte Holz ist in Deutschland z. Zt. überhaupt nicht zu beschaffen wenn es sich um grosse Fälle handelt. Daher ist das rechtzeitige Erkennen, die Vorbeugung, die planmässige Bekämpfung und das frühzeitige Beseitigen der Schäden eine Forderung die sich aus den deutschen Erfahrungen ergibt.

Wenn in anderen Ländern Holz und auch Geld nicht so knapp ist, wie z. Zt. in Deutschland, so kann aus unseren Friedenserfahrungen gesagt werden, dass die hem-

mungslose Verbreitung des Hausbocks auch in einem wohlhabenden Lande zu so schwerwiegenden Vermögensschäden führen kann, dass man auch hier — soweit es noch nicht geschehen — mit aller Energie den Kampf gegen den Zerstörer von verbautelem Holz aller Art, vom Dachstuhl bis zum Telegrafmast und Möbelstück, aufnehmen sollte. Wir geben gerne unsere Erfahrungen weiter.

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## DIE PRIMÄRITÄT UND SEKUNDÄRITÄT ALS EIGENSCHAFTEN DER SCHÄDLINGE

Von *Esko Kangas*

Das Ingangkommen einer Schädigung in der lebenden Pflanze ist ein in hohem Masse interessantes Naturereignis. Es ist, wie man feststellen kann, im allgemeinen abhängig einerseits von den Eigenschaften seines Urhebers — im vorliegenden Zusammenhang des schädlichen Insekts — anderseits von denjenigen des von der Schädigung betroffenen Gegenstandes — in diesem Falle des Baumes —, m. a. W., es sind hier zwei lebende Organismen, der Schadenurheber und das Schadenobjekt, in gegenseitigen Kampf geraten. Je nach dem Fall werden nun die Eigenschaften beider in verschiedener Weise — oder in verschiedenem Ausmass — darauf einwirken, ob der Schaden wirklich in Gang kommt oder nicht. Als Extremfälle ergeben sich natürlich diejenigen, wo der eine von beiden in bezug auf das Ingangkommen des Schadens überhaupt kein Wortrecht hat, sondern der Ausbruch des Schadens entweder ausschliesslich von seinem Urheber (dem Insekt) oder ausschliesslich von seinem Gegenstand (dem Baum) abhängig bleibt. Bei der theoretischen Auseinandersetzung dieser Verhältnisse muss man sich natürlich zuerst mittelmässig zwischen den genannten zwei Extremen bewegen, damit sich von diesen Ereignissen ein möglichst richtiges Bild ergäbe. Dabei ist der Vereinfachung halber einstweilen auch der Einfluss der äusseren Faktoren auf den Vorgang gänzlich zu übersehen. Die Betrachtung beschränkt sich naturgemäss auf die biotischen Schadenurheber, hier die Insekten.

Als wichtigste Umstände, denen von seiten des Schadenurhebers die grösste Bedeutung für das Ingangkommen des Schadens zukommt, ergeben sich 1. die Eigenschaft, die es bestimmt, ein wie beschaffener Baum von dem betreffenden Insekt überhaupt angegangen werden kann (diese Eigenschaft des Schadenurhebers kann dazu noch Schwankungen unterworfen sein); 2. der Zeitpunkt, wo sich der Schadenurheber in einem solchen Entwicklungsstadium befindet, dass er zu einem Angriff überhaupt fähig ist (sog. Angriffszeit); 3. die zum Angriff erforderliche Menge des Schadenurhebers (Grösse seines Bestandes). Auf der Seite des vom Schaden betroffenen Gegenstandes (= des Baumes) sind solche Umstände in erster Hand 1. die Lebenskraft, der Gesundheitszustand und das Entwicklungsvermögen (oder deren Summe, also der physiologische Allgemeinzustand des Baumes, der naturgemäss ebenfalls verschieden sein kann); 2. die angeborene Neigung des Baumes, von einem bestimmten Schadenurheber befallen zu werden (Affinität). Nehmen wir an, dass die in bezug auf beide Beteiligten zuletzt genannten Umstände, also der Bestand des Schadenurhebers und die Affinität des Schadenobjekts, in einem für das Ingangkommen des Schadens hinreichenden Betrag verwirklicht sind, so ergibt sich als weitere Voraussetzung für den Schadenausbruch, dass die zuerstgenannten Eigenschaften der Beteiligten, also beim Schädling diejenige, die es bestimmt, welcher ein Baum von ihm angefallen werden kann, und beim Baum sein allgemeiner Zustand, einander zufälligerweise entsprechen, m. a. W., dass zufälligerweise eben diese Kombination zustandekommt. Entscheidend für den Ausbruch des Schadens wird dann schliesslich der Umstand, ob seinerseits dieses Zusammentreffen der Eigenschaften wieder in den Zeitpunkt, d. h. in die Jahreszeit fällt, in welchem sich der Schadenurheber eben in dem Entwicklungsstadium befindet, dass sein Angriff

überhaupt möglich ist, also ob dieses Zusammentreffen gleichzeitig auch mit der sog. Angriffszeit des betreffenden Schadenurhebers zusammenfällt (vgl. K a n g a s 1946, p. 109—114 bzw. 184—185).

Von denjenigen Eigenschaften des Urhebers sowie des Gegenstandes der Schädigung, von denen, wie wir oben feststellten, das Ingangkommen des Schadens hauptsächlich abhängt, wurden bereits die anderen (Affinität und Zustand des Baumes, Grösse des betreffenden Schädlingsbestandes und die Angriffszeit) definiert und benannt, nicht aber noch diejenige Eigenschaft des Schadenurhebers, welche entscheidet, ein wie beschaffener Baum vom betreffenden Schädling überhaupt angegangen werden kann. Wenn in der Forstentomologie — und in der angewandten Entomologie überhaupt — diese Charaktereigenschaft des Schadinsekts zur Sprache genommen wird, so spricht man von primären und sekundären Schädlingen. E s c h e r i c h z. B. legt in seinem bekannten Handbuch (1913, p. 197) die Sache folgendermassen aus:

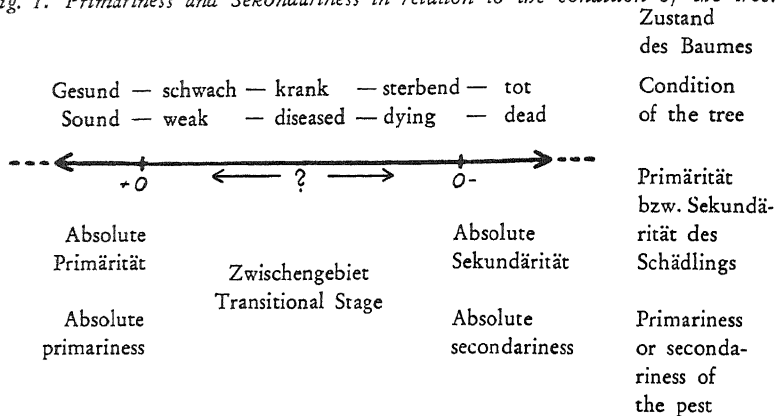
„Wenn wir von primären und sekundären Schädigungen reden, so legen wir dieser Einteilung den jeweiligen Gesundheitszustand der Pflanzen zugrunde, indem wir als primär solche schädlichen Insekten bezeichnen, welche völlig gesunde Pflanzen angehen, und als sekundär solche, welche für gewöhnlich nur kränkeldes Pflanzenmaterial mit schwachem oder stockendem Saftstrom befallen. Eine scharfe Grenze lässt sich aber auch hier nicht ziehen, indem zwischen den ausgesprochen primären und den ausgesprochen sekundären Insekten eine ganze Reihe von Zwischenstufen liegen, von denen man mitunter im Zweifel sein kann, ob sie in die erste oder zweite Kategorie zu stellen sind. Ferner kann es auch vorkommen, dass ausgesprochen sekundäre Schädlinge primär werden, wenn nämlich nach eingetretener Übervermehrung ein Mangel an geeignetem kränklichen Material eintritt. Dann treibt der übermächtige Fortpflanzungstrieb die Tiere dazu, auch völlig gesunde Pflanzen anzugehen, was allerdings oft vielen der betr. Insekten das Leben kostet.“

Wir sehen also, dass zwischen den Begriffen „primär“ und „sekundär“ eigentlich keine distinkte Grenze gezogen werden kann. Freilich schiene die sog. absolute Primärität wenigstens beim ersten Hinsehen wohl deutlich umgrenzbar zu sein: sie wäre eben durch den Befall völlig gesunder Bäume angedeutet. Und theoretisch liesse sich wohl natürlich auch der Begriff der Sekundärität z. B. insofern kondensieren, als eine absolute Sekundärität nur durch den Angriff auf schon tote Bäume (also solche, die ihre Lebensbestätigungen bereits eingestellt haben) repräsentiert wäre. Die Grenzen wären also deutlich genug: auf der einen Seite der gesunde, auf der anderen der tote Baum. Wie wären aber die zwischen diesen Endpunkten sich einfügenden Fälle zu bezeichnen und zu beschreiben? (Vgl. Abb. 1.) Übrigens können, wenn man tiefer in die Sache eindringt, auch in bezug auf die hier angedeuteten Grenzen Einwände vorgebracht werden. Was versteht man z. B. unter einem gesunden Baum? Wie lautet seine Definition? Auch der Zustand eines gesunden Baumes variiert und kann also vom Standpunkt des angreifenden Insekts ein nicht wenig verschiedener, verschiedenwertiger, sein. Und ferner: auch ein toter Baum repräsentiert nach dem Aufhören seiner Lebenstätigkeit vom Standpunkt des Insekts und im Hinblick auf dessen Sekundärität keineswegs einen permanenten Zustand, einen Status quo, sondern auch der (physiologische) „Zustand“ eines toten Baumes ändert sich unablässig, und zwar nicht nur geradlinig, sondern es können sich die verschiedenen Zustände nach Massgabe der äusseren Verhältnisse (z. B. der Feuchtigkeit) abwechselnd wiederholen. Es stellen somit weder die absolute Primärität noch die absolute Sekundärität in ihrer obigen Umschreibung eine einheitliche Kategorie dar,

sondern dieselben Gradunterschiede gelten in ihrem Kreise ebenso gut wie im zwischenliegenden Gebiet. Wir könnten das Gesagte recht einfach wie folgt veranschaulichen:

Abb. 1. Die Primärität und Sekundärität in ihrem Verhältnis zum Zustand des Baumes.

Fig. 1. *Primariness and Sekondariness in relation to the condition of the tree.*

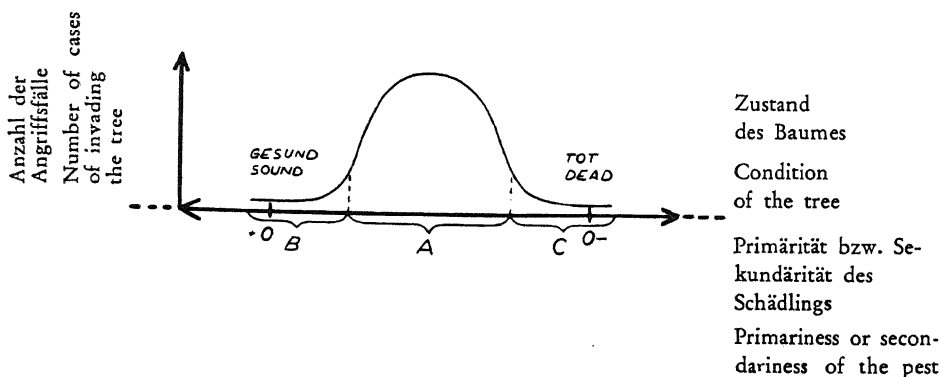


Es handelt sich also stets nur um einen gewissen, dem verschiedenen Zustand des Baumes entsprechenden Grad der Primärität (bzw. der Sekundärität), m. a. W. um den verschiedenen Ausbildungsgrad ein und derselben Eigenschaft.

Zu dem Obigen gesellt sich noch als ein zu berücksichtigender Umstand die Schwankung der Primärität und Sekundärität bei ein und demselben Schadenurheber. Hierauf weist schon Escherich (1913) in seinem obenangeführten Zitat hin, doch spricht er hier von einer durch äusseren Zwang hervorgerufenen Schwankung; ich werde auf diese Frage später noch zurückkommen. Die fragliche Schwankung äussert sich aber bei einem Schädling auch als eine ihm angeborene Charaktereigenschaft. Wir könnten vielleicht auch dieses Verhältnis graphisch wiedergeben, etwa folgendermassen (Abb. 2):

Abb. 2. Schwankung der Primärität bzw. Sekundärität der Art.

Fig. 2. *Fluctuation of the Primariness or Secundariness of the Species.*



- |   |   |
|---|---|
| <p>A. Normale Primärität bzw. Sekundärität der Art (= „Neigung“ oder „Inklination“) (<i>vom Standpunkt des Schädlings</i>: optimaler Zustand des Baumes).</p> <p>B. Variation nach der + -Richtung (<i>vom Standpunkt des Baumes</i>: gesteigerte Aktivität des Schädlings; <i>von demjenigen des Schädlings</i>: Vorliebnahme unterhalb des Optimums stehender Verhältnisse).</p> <p>C. Variation nach der — -Richtung (<i>vom Standpunkt des Baumes</i>: gesteigerte Passivität des Schädlings; <i>von demjenigen des Schädling</i>: Vorliebnahme unterhalb des Optimums stehender Verhältnisse).</p> | <p>Normal primariness or secondariness of the species (= "inclination") (<i>from the pest's point of view</i>: optimal condition of the tree).</p> <p>Change towards the positive direction [= <i>from the point of view of the tree</i>: becoming more active (primary); <i>from the point of view of the pest</i>: submitting to conditions less than the optimum].</p> <p>Change towards the negative direction [= <i>from the point of view of the tree</i>: becoming more passive (secondary); <i>from the point of view of the pest</i>: submitting to conditions less than the optimum].</p> |
|---|---|

Mit anderen Worten: denken wir uns die Angriffsfälle eines gegebenen Schädlings gemäss der dargestellten Primäritäts- und Sekundäritätsskala sortiert, so werden wir sehen, dass die überwiegende Mehrzahl der Fälle, wenn dem Schädling freie Wahl bezüglich ihrem Zustande nach verschiedener Bäume vorliegt, sich innerhalb eines bestimmten Gebietes auf dieser Skala häufen wird, d. i., sie repräsentieren die normale Angriffsfähigkeit der Art oder also den vom Standpunkt des Schädlings optimalen, d. h. angriffstauglichsten Zustand des Baumes. Dies möchte ich als die „Neigung“ („Inklination“), Vorliebe des betreffenden Schädlings bezeichnen (A!) (K a n g a s 1946, p. 111 und 117—118, bzw. 184 und 186). Gleichzeitig kommen aber stets auch Fälle, Individuen der betreffenden Schädlingsart vor, die ihre Angriffe auf Bäume ober- bzw. unterhalb jenes Optimalgebietes, also auf im Vergleich zum Gewöhnlichen gesündere bzw. krankere Bäume richten, m. a. W. eine grössere Primärität bzw. Sekundärität an den Tag legen, also von ihrer gewöhnlichen, charaktereigenen Neigung abweichen (B und C!). In solchen Fällen hat sich der Schädling mit Verhältnissen (Bäumen) begnügt, die hinter denjenigen des Optimalgebietes zurückstehen, oder, vom Standpunkt des Baumes betrachtet: er ist entweder aktiver (durch seine Angriffe auf gesündere Bäume als sonst) oder passiver (durch seine Angriffe auf schwächere Bäume als sonst) geworden (K a n g a s 1946, p. 118 bzw. 186). — Jenes geschilderte Verhalten der Schädlinge zu Bäumen verschiedenen Zustandes ist bei manchen von meinen Untersuchungen über die Vertrocknung der Bäume u. dgl. m. (z. B. K a n g a s 1934 a und b, 1936, 1937, 1938, 1942, 1946) und nun zuletzt auch im Zusammenhang mit der Ermittlung der Folgen der im vergangenen Winter in Ost- und Mittelfinnland eingetroffenen gewaltigen Schneeschäden (vgl. K a n g a s 1948) u. a. in betreff vieler rindenbewohnenden Arten deutlich zutagegetreten. In diesen Fällen haben zumal den Schadenurhebern in ausserordentlich reichlichem Masse Bäume verschiedensten Zustandes, von völlig gesunden bis zu dicht an der Grenze des Todes stehenden Bäumen, herabgefallene (und schon tote) Wipfel, ihrer ganzen Länge nach umgefallene (zu Boden gedrückte) und als anschliessende Gruppe schon früher beschädigte Bäume, zur Verfügung gestanden.

Indem ich oben von einem vom Standpunkt des Baumes Aktiver- bzw. Passiverwerden des Schädlings sprach, hat es sich um eine normale, mit der spezi-

fischen Natur der Art zusammenhängende Erscheinung gehandelt. Ob diese Schwankung ausschliesslich von der im Kreise der Art existierenden Individualität abhängig ist, kann in Frage gestellt werden. Wenigstens einige von meinen Beobachtungen deuten darauf hin, dass bei manchen Arten (z. B. bei gewissen *Pissodes*-Arten) auch ein und dasselbe Individuum Bäume verschiedenen Zustandes angreifen kann. — In dem von Escherich (1913) angedeuteten Fall, auf den ich schon vorhin hinwies und in welchem die Art mitunter aus Zwang eine grössere Primärität als gewöhnlich erlangt, haben wir es hinwieder mit einer anderen Art von gesteigerter Aktivität, mit einer Zwangsaktivität, zu tun (Kangas 1946, p. 114 bzw. 185). Diese beruht dann darauf, dass dem Schädling — jedenfalls im Hinblick auf die Grösse seines Bestandes — keine oder jedenfalls nicht in genügender Menge unter normalen Verhältnissen geeignete, also im optimalen Zustand oder innerhalb der Grenzen der normalen (natürlichen) Variation beiderseits desselben befindliche Bäume zu Gebote stehen, und der Fortpflanzungsdrang treibt dann den Schädling zum Angriff auf Bäume, denen er nicht gewachsen ist, m. a. W. deren Zustand dem Angriffsvermögen des Schädlings übermächtig ist. In solchen Fällen misslingt auch der Angriff, d. h., der Schädling vermag sich im befallenen Baum nicht zu vermehren — auf jeden Fall nicht ehe sich der Zustand des Baumes als Folge der wiederholten Angriffe hinreichend geschwächt hat. Ein solches zwangsmässiges Vorkommen kann auch nach der negativen oder also nach der „sekundären“ Richtung hin stattfinden, die Art kann nämlich auch zwangsmässig passiv auftreten, d. h. obligatorisch sekundärer als gewöhnlich werden (z. B. wenn sie bei Massenaufreten auch solches Material, z. B. Hiebsreste, angeht, das ja in bezug auf eine erfolgreiche Vermehrung durchaus hoffnungslos ist). — Im vorliegenden Zusammenhang mag festgestellt werden können, dass das Misslingen des Schädlings bei seinen Versuchen, einen Baum anzugreifen oder sich dort erfolgreich zu vermehren, noch an sich nicht zeigt, dass es sich um zwangsmässige Aktivität (bzw. Passivität) handelt. Auch in Verbindung mit der normalen Variation der Primärität (bzw. Sekundärität) kann es zu fehlgeschlagenen Angriffen kommen (vgl. Kangas 1938, p. 85—88).

Wie aus dem Obigen hervorgegangen sein dürfte, vertreten die Begriffe „primär“ und „sekundär“ zusammen diejenige Eigenschaft des Schadenurhebers, welche es bestimmt, ein wie beschaffener Baum vom betreffenden Schädling überhaupt befallen werden kann; ebenso ist hervorgegangen, dass diese Eigenschaft keine permanente ist, sondern sich innerhalb bestimmter spezifischer Grenzen bewegt. Diese Eigenschaft müsste nun ebenfalls mittels eines monotypen Begriffes zu definieren sein, und ich schlage deshalb zum präliminären Gebrauch (also einstweilen völlig provisorisch) z. B. den Ausdruck „Angriffsvermögen“ vor (man vergleiche oben den Ausdruck Angriffszeit). Sein Kern, die sog. Neigung (Inklination), ist für jede Art ausgesprochen charakterigen (genotypisch), ebenso auch seine Variationsamplitude (auf jeden Fall deren äussersten Grenzen). Der jeweilige Betrag und die Breite der Variation (jener sicher, diese wahrscheinlich) sind wiederum abhängig von der Physiologie (dem „Zustand“) der Art sowie von anderen äusseren Faktoren (Verhältnissen). — Wir haben ferner gesehen, dass die genannte Eigenschaft (als Folge des Einflusses äusserer Faktoren) auch einer sog. zwangsmässigen, obligatorischen Variation unterliegen kann (zwangsmässige Primärität bzw. Sekundärität). Diese Variation dürfte wohl am besten als eine getrennte, obwohl in ihrer Art ebenfalls dem Begriff des Angriffsvermögens zufallende, durch abweichende äussere Verhältnisse hervorgerufene Erscheinung zu deuten sein.

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# PRIMARINESS AND SECONDARINESS AS A CHARACTERISTIC OF PESTS.

## Summary.

The initiation of damage in a living plant caused by a pest is generally dependent on the characteristics of the plant (here, the tree), on the one hand, and of the pest (here, the insect), on the other hand; the extreme cases and the influence of external factors one can at first ignore, in order to simplify the matter. The most important characteristics which are significant at the start of the damage are: (a) as regards the pest, 1) the factor which determines what kind of tree (in what condition) the pest normally attacks, 2) the time at which the pest is in such a state of development that it can normally attack the tree (the time of attack), 3) the numbers of the pest (the size of the pest population); (b) as regards the pest's objective 1) the vitality, capability of development and state of health of the tree, that is, the sum of these (= the condition of the tree), 2) the innate tendency to become a victim of the pest (= the affinity). Apart from the necessary size of the population and the affinity, it is therefore essential for the pest to find trees in a suitable condition (fulfilling its requirements) which it is capable of attacking. The deciding factor in the initiation of damage is ultimately whether or not here exists in such a condition at just the time that the pest attacks (Kangas, 1946, p. 109—114 or 184—185).

When one observes the characteristic of the pest which decides what kind of condition of the tree the pest generally attacks, one notices that in the field of applied entomology reference is made to primary and secondary pests, (compare, for instance, Escherich 1913, p. 197). A clear limit between these conceptions it is not possible to draw (comp. Escherich 1913, p. 197). It is not possible to limit with any certainty even the so-called absolute primariness (only attacking perfectly healthy trees) — for instance, what is the healthy tree, how is it defined? The condition of even healthy trees is of varying value, when they are compared with one another. If one tries to define absolute secundariness, also, (for example, as the attacking of dead trees only) one comes up against the same difficulty (even dead trees are physiologically in very different states). The primariness and secundariness are thus only different names for one and the same characteristic, a characteristic which thus always corresponds to a certain condition of the tree; and to describe its intensity, it is possible to put forward a scale of some kind, such as that in figure 1. But this characteristic is not constant for any species nor represented by only point on this scale; it always varies to a greater or lesser extent. If this variation is taken into



account, it is possible, by this scale, to describe the characteristic in question (i. e. the primariness or secundariness) graphically with a curve, as for instance in the manner shown in figure 2. Various cases, which form the basis of his report, have often been noticed in nature in many investigations made by the author on the drying of trees, etc., (e.g. K a n g a s 1934 a, b, 1936, 1937, 1938, 1942, 1946) and lastly, also, in connection with investigations which are still going on concerning damage following after snow damage (c.f. K a n g a s 1948).

It can thus be stated that, when primariness and secundariness are referred to, only different stages of one and the same characteristic are in question. A term is needed for this characteristic, which corresponds to its singleness of concept (for instance, the capacity to attack). This characteristic exists in each species, varying between the limits which are peculiar to it, and, in this variation, a so-called normal or optimal area ("inclination") and variation areas (increased normal activeness and passiveness) are to be distinguished. All this is genotypically determined for the species. The amount of variation itself in each case (from the optimal area towards the extreme values) and possibly also its amplitude in each case are environmentally determined for the species. Likewise, the so-called obligatory increase in primariness or in secundariness (obligatory activeness or passiveness), necessitated by a lack of material for reproduction normally suitable for the species, which is to be kept quite separate, is, of course, also a phenomenon completely dependent on external circumstances.

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## LES INVASIONS DES BOSTRYCHES DANS LES FORÊTS DE LA TCHÉCOSLOVAQUIE

Par A. Pfeffer

Dans les années 1943/44 et 1944/45 on a exploité deux fois plus de bois dans les forêts de la Tchécoslovaquie que ne faisait la masse de l'accroissement. Étant donné que, par suite d'un manque de main-d'oeuvre, le bois abattu est resté dans une large mesure non écorcé dans les peuplements, une gradation notable des bostryches apparut pendant l'année 1945 dans les forêts des montagnes de la partie Ouest de la république. Le plus se multiplièrent les espèces suivantes: *Ips typographus* L., *Ips amitinus* Eichh., *Pityogenes chalcographus* L., qui furent rencontrés ensemble. D'abord ils n'attaquaient que certains arbres mais, par la suite, l'invasion se groupait en nids qui, à la fin, se répandirent sur des étendues considérables. Dans les années 1946 et 1947 le bostryche le plus dangereux, *Ips typographus* L., apparut, bien qu'en nombre médiocre, même dans les régions plus basses, où l'épicéa fut introduit artificiellement et où il ne fut jamais trouvé auparavant, même si l'épicéa y fut cultivé depuis trois générations. Pour comprendre la situation dans les forêts de la Tchécoslovaquie il faut mentionner que normalement, ce bostryche ne se rencontrait que dans les régions depuis 700 m d'altitude. Ces parties, bien que boisées sur une surface de 60 % et plus, ne forment, en tant que forêts, qu'à peine 5 % de l'étendue totale des pays tchèques, mais à peu près 25 % de son étendue totale des forêts. Cependant l'attaque principale de ce bostryche se bornait aux stations montagneuses. Le bostryche *Ips cembrae* Heer. ne fut trouvé qu'occasionnellement sur l'épicéa. Le bostryche *Ips amitinus* Eichh. en surabondance seulement dans les régions les plus hautes.

L'essaimage de printemps dans les années 1945 et 1946 eut lieu dans la première moitié de mai, dans les années 1947 et 1948, sous l'influence d'une chaleur anormale, déjà vers la fin d'avril. L'essaimage d'été s'échelonnait irrégulièrement dans les mois de juillet, d'août et de septembre. Le bostryche hivernait moitié comme insecte parfait de la deuxième génération, moitié comme larve ou chrysalide de la même génération.

Le bostryche *Ips typographus* L. commençait par se jeter sur les troncs sur pied, de même que sur les arbres-pièges dans la partie de transition entre les branches mortes et les branches vertes. Après l'attaque de printemps qui se fait en masse, les arbres commençaient à rougir au cours d'un mois. Après l'attaque d'été qui dure plusieurs semaines, l'arbre en apparence ne change pas; c'est seulement au printemps que le rougissement de son houppier apparaissait d'un seul coup. Au printemps, les bostryches envahissaient le tronc depuis sa base jusqu'aux parties basses de la couronne, pendant que, en été, seulement plus souvent les parties basses de la couronne furent endommagées. Le bas de l'arbre, même chez les fûts sur pied, resta intacte pendant tout l'automne et l'hiver et c'est seulement au printemps suivant qu'il fut attaqué, outre le bostryche liseré *Xyloterus lineatus* Ol., par des espèces tout-à-fait secondaires: *Hylurgops palliatus* Gyll., *Ips laricis* Fabr., *Crypturgops pusillus* Gyll., qu'accompagnait, dans les montagnes, *Crypturgops hispidulus* Thoms.

Sur les bris de vent et de neige se jetèrent aussi les espèces dangereuses, *Ips typographus* L., *Ips amitinus* Eichh. et *Pityogenes chalcographus* L. sur les morceaux de tronc avec cime gisant par terre seulement, pendant que les moignons sur pied, mais

sans couronne, furent occupés par les espèces inoffensives déjà citées. C'est pourquoi on ne doit jamais faire de ces moignons des arbres-pièges.

Dans l'emploi des arbres-pièges comme moyen réprésif ces règles pratiques eurent du succès :

Dans les hauteurs de 700 m. les arbres-pièges furent situées près de la lisière des peuplements, sans être livrés à une ensolation trop forte. Dans les régions plus élevées les arbres-pièges furent placés dans la lisière même. On mettait sous les extrémités des arbres-pièges des supports pour utiliser leur superficie entière, car, chez les arbres-pièges couchés par terre, la partie d'endessous ne fut occupée que par des espèces innocentes, comme *Hylastes cunicularius* Er., *Dryocoetes autographus* Rtz. et dans les régions plus élevées par les espèces *Hylastes subalpinus* Eggers in. litt. et *Dryocoetes hectographus* Rtt. On ne peut conseiller la combustion de l'écorce des arbres-pièges contenant seulement des larves et des chrysalides pour des questions de temps et à cause du danger des incendies. Le pourcentage des femelles qui, après l'écorçage, pouvaient encore fonder une génération-soeur, peut être évalué à peine à 2 % du nombre total des larves et des chrysalides qui arrivent à être détruites par le soleil seul. Là seulement, où l'on a commencé trop tard à écorcer, c'est-à-dire là, où l'évolution de l'insecte parfait est achevée, il faut absolument brûler l'écorce. La destruction des bostryches hivernant dans la litière n'a pas trop de succès, car on y a trouvé au plus 5 % de l'habitation totale du tronc. Outre cela, le soutrage est dans bien des régions une question angoissante de la protection des forêts.

Pour contrôler un grand nombre d'arbres-pièges il suffit de voir si l'arbre est attaqué à la transition des branches mortes aux branches vertes. S'il n'y a pas de bostryches (*Ips typographus* L.) dans cette partie, il n'y en a pas d'avantage autre part.

L'hylésine *Polygraphus polygraphus* L. nuisait surtout dans les régions peu élevées, où l'épicéa a été introduit artificiellement. Il a été dangereux sur des stations assez sèches, où il attaquait les arbres sur de petites places circulaires. Jamais il n'en résulta une invasion étendue, comme il en était chez les bostryches *Ips typographus* L., *Ips amitinus* L. et *Pityogenes chalcographus* L. Il attaquait très souvent en compagnie des charançons *Pissodes harcyniae* Hbst., *Pissodes scabricollis* Mill. et dans les régions plus élevées en compagnie du hylésine *Polygraphus subopacus* Thoms. L'inoffensif *Crypturgus subcribosus* Egg. ne fut jusqu'à présent trouvé que dans le piceetum des Carpathes en compagnie des espèces précédentes. On a de même observé l'espèce *Polygraphus grandiclava* Thoms. comme étant un insecte innocent des régions montagneuses ou des bords des tourbières.

Notre plus grand bostryche, *Dendroctonus micans* Kug. ne tendait pas à se surpeuler sensiblement. On a trouvé que son évolution dure deux ans complets, ce qui n'est pas, sûrement, sans conséquences pour la vitesse de sa gradation. Après l'essaimage en juillet et août, la larve hiverne et se métamorphose en insecte parfait en août de l'an suivant. L'insecte parfait hiverne célibataire tout en pratiquant un forage de maturation, qui dure jusqu'en été de la troisième année, où, en août, il fonde une nouvelle génération. C'est pourquoi nous pouvons trouver en même temps, sur un seul arbre même, des femelles en train de pondre leurs oeufs et des insectes parfaits récemment nés. Nous avons donc là affaire à une évolution semblable à celle de *Hylurgops glabratus* Zett. et de *Hylesinus crenatus* Hrbst. que j'ai observée. On rencontre le bostryche *Dendroctonus micans* Kug. depuis la plaine jusqu'aux sommets des montagnes, mais sa région typique est dans les peuplements de vieux épicéas près de la limite suprême des forêts. Il y attaque les arbres un à un d'abord dans la partie de bifurcation des rameaux et il

descend peu à peu jusqu'au pied de l'arbre; il met dix années à le faire mourir car, au cours de la première année seulement un forage complémentaire a lieu, l'an suivant le forage larvaire qu'accompagne, au cours de la troisième année, l'attaque des longicornes *Tetropium luridum* L., *Tetropium fuscum* Fabr. et *Callidium coriaceum* Payk. qui est assez rare. En somme l'attaque annuelle peut être évaluée à 1 % du nombre total des arbres des hautes montagnes et en somme 10 % de tous les arbres sont atteint par une des étapes de l'invasion depuis le forage de maturation jusqu'à la mort complet de l'arbre.

Des autres espèces de bostryches vivant sur l'épicéa furent observés en grand nombre, bien que sans danger pour la forêt : *Cryphalus abietis* Rtzb., *Phthorophloeus spinulosus* Rey., *Cryphalus saltuarius* Wse., *Hylurgops glabratus* Zett., *Pityophthorus pityographus* Trb., *Pityophthorus exculptus* Rtzb. et *Ips suturalis* Gyll.

Pendant la guerre eurent lieu de nombreux transports de bois de l'Europe du Nord, qui entraînèrent dans l'Europe Centrale des espèces qu'on y a pas observées jusqu'alors. Ce sont *Pityophthorus micrographus* L. (syn. *Pit. fennicus* Egg.) et *Pityophthorus morozovi* Spess., qui attaquait l'épicéa *Picea pungens*, cultivé dans les jardins le long des chemins de fer. Depuis on n'a pas constaté son acclimatation dans nos forêts.

En conclusion on peut évaluer le total des arbres morts annuellement par suite de l'invasion des bostryches dans les années 1945—1948 à 600—700.000 m<sup>3</sup> ce qui fait 10 % du rendement total en masse de la Bohême, de la Moravie et de la Silésie. Actuellement l'invasion tend à décroître, mais on doit s'attendre à de graves conséquences de la sécheresse désastreuse de l'an passé.

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## THE INTERNATIONAL COMMITTEE FOR APPLIED ENTOMOLOGY

By J. M. Rásek

During the recent events of the World-war II, all the good international cooperation on the field of Economic entomology was badly disturbed. It is certainly very advisable now, to take up again this important activity and therefore I consider it useful to summarize in this report as its secretary the prewar activities and organisation of the "International Committee for applied Entomology."

There are important *economic necessities* of the present day, especially the increasing importance of the *nourishment* of the world population and the supply of raw-materials, which are forcing us, to devote increased international attention to injurious insects, which are spreading across all the boundaries of individual states.

Therefore it is natural, that these questions were considered long time ago at the meetings of International congresses of Zoology and Entomology.

A positive shape to this line of work was given on the X. International Zoological congress in Budapest 1927. Here the Director of the Entomological Institute in Budapest, J. Jablonowski, gave in the meeting of the Section for Economic entomology an alarming paper: "The present international fruit-trade as a new source of danger of introduction of foreign injurious insects." His report promoted great interest and a thorough discussion of this problem. The author of this report suggested, that this international danger must be checked by an *international organisation*. It was pointed out, that the State phytopathological service of each state must in the first place pay a great deal of attention to the *Prophylaxis* (that means preventing the injurious insect from being introduced into the state) and as a basis for this, it needs the possibility of making *prognosis* in due time of each possibility of catastrophical spreading or introducing of any kind of injurious insect. The prerequisite for fulfilling of these two important tasks is the existence and correct functioning of an *International entomological information service*. The duty of such a service would be to give quick and correct information about the existence and spreading of centers of injurious insects. Such a service would enable the State phytopathological service of each State to prepare a quick prognosis of a danger and of the possibility of introduction of a new damager and the quick preparation of all the necessary prevention- and prophylactic measures.

It was also suggested, that this service should be organised by the International Agricultural Institute in Rome. The Section favourably accepted these suggestions and as a result on the final plenary session of the Congress two important measures were taken and that:

I. A special permanent "International Committee for applied Zoology" was nominated. As chairman was elected a well known expert on this field, Dr. L. O. Howard from Washington, U.S.A. Further members of the Committee were:

Dr. F. S. Bodenheimer, Tel Aviv, Palestina.

Dr. J. Jablonowski, Budapest, Hungary.

Ing. J. M. Rásek, Brno, Czechoslovakia.

Dr. Fr. Zacher, Berlin, Germany.

II. A resolution was passed, in which the International Agricultural Institute in Rome was asked to establish such a quick, frequent and correct international entomological information service about the increased occurrence and introduction of injurious insects.

A detailed account of all these negotiations is given in the Proceedings of the X. International Zoological congress at Budapest, 1927, Tome II. pg 1173—1180.

The International Agricultural Institute in Rome accepted the recommendations of this congress. It created a special international Committee for the questions of plant-protection and called some special conferences about individual, specially injurious insects. Only the required international information service was (with respect to the further development) not yet organised in a satisfactory way.

The elected Committee for applied zoology continued its negotiations on the further meetings of the Zoological congress at Padua 1930, and especially at the XII. Congress held in Lisbonne 1935. Presiding was Dr. Bodenheimer (as Dr. Howard was not present) and for secretary was elected Rašek. The number of members was increased to 15. It became necessary to divide the Committee into two sections and that:

- I. Committee for applied *Entomology*
- II. Committee for applied *Hydrobiology*.

The Committee for Entomology accepted next to the organisation of the International Entomological information service (as it was described above) another working program, to prepare an *international map* in which all the spreading and introduction of individual important species would be described.

Some species have been divided to following workers:

Mr. Bodenheimer (Jerusalem)	will work on	Calandra sp.
Mr. Eidmann (Han. Münden)	„ „ „	Monomorium and Iridomyrmex
Mr. Mimeur (Rabat)	„ „ „	Aphids sp.
Mr. Prell (Tharandt)	„ „ „	Scarabeid sp.
Mr. Rašek (Brno)	„ „ „	Liparis monacha.

The details of these negotiations are given in the Proceedings of the XII. Zoological Congress at Lisbonne 1935, Tome I. pg. 202—205.

It certainly is very necessary to take up this useful and important work again. The close cooperation of the International Congress of Entomology with the above-mentioned Committee for applied Entomology of the Zoological Congress would be most desirable and welcome.

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## CONTRIBUTIONS TO THE BIOLOGY OF *Xyloterus domesticus* L. AND *Hylecoetus dermestoides* L., TWO WOOD- BORING COLEOPTERA

By *Mathias Thomsen*

### I.

During the years 1940—43 an extensive outbreak of the Beech coccid (*Cryptococcus fagi* Baer.) occurred in Denmark. In localities where the coccids were especially numerous many trees were killed or brought down by wind. This was not a direct consequence of the coccid infestation, but due to a whole series of parasites, *Cryptococcus* being, however, the primary pest which prepared the trees for the secondary enemies. The second to appear was the fungus *Nectria galligena*, which continued the destruction of the bark, and nearly at the same stage two species of wood-boring beetles arrived, and finally came *Polyporus*, *Fomes* and other wood-destroying fungi. The whole series of events resembles cases described by Rumbler in Germany and by Ehrlich in Eastern Canada. Our investigations will be recorded in detail in another paper, (Thomsen, Buchwald and Hauberg 1949), here I shall confine myself to a discussion of some points in the bionomics of the wood-boring Coleoptera *Hylecoetus dermestoides* and *Xyloterus domesticus*. For further particulars and figures the reader is referred to our detailed paper.

### II.

*Xyloterus domesticus* L. (= *Trypodendron domesticum* L.) is a well known scolytid beetle. Here I shall only turn the attention to the pronounced sexual dimorphism of the species. The pronotum of the male is almost quadrangular when seen from above, broader than long, dorsally somewhat flattened and densely covered with hairs. The pronotum of the female is arched, anteriorly curved, more granulated, but less haired. The morphology of the head is very different in the two sexes (fig. 1—2). In the male of the front is concave, and laterally there is a fringe of long hairs; on the lower side there is a semicircle of stout yellow hairs, almost like a "beard", decreasing in length anteriorly. It seems a reasonable suggestion to regard these differentiations as a "brushing apparatus" for clearing the burrows of bore-meal. In the female the front is convex, and the hairs are much weaker.

Though *Xyloterus domesticus* is mentioned in all works on European bark-beetles, many points of the life-history are unknown, and as to the number of generations the authors disagree. The related species, *X. lineatus* Oliv., has, however, been thoroughly treated in an excellent paper by the Swiss entomologist Charles Hadorn (1933). This species breeds in coniferous trees, especially felled stems of spruce, while *X. domesticus* only occurs in hardwood, mostly beech.

The general shape of the galleries was already described by Ratzeburg. There is a horizontal entrance tunnel, which forks into 2—4, most commonly 3, egg-tunnels. The larval burrows or chambers form two vertical rows, one above and one below the egg-galleries. In our material the egg-galleries varied from 10—75 mm in length, the larval chambers were 4—5 mm long; the maximum number of larvae per gallery is probably between 60 and 70, with a "density" of 4—6 per centimeter egg-tunnel.

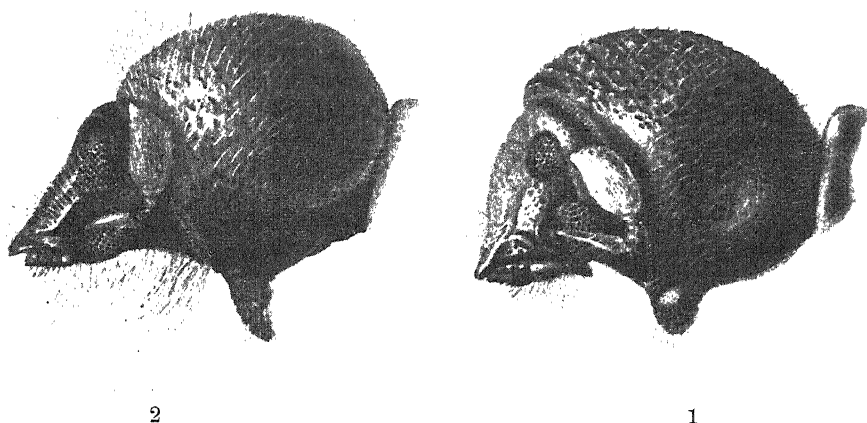


Fig. 1. *Xyloterus domesticus* L. Head and thorax of male. 33 x.  
Fig. 2. *Xyloterus domesticus* L. Head and thorax of female. 33 x.

One may perhaps distinguish between two types of galleries, one type with long egg-tunnels running nearly parallel almost to the centre of the tree, and another one with rather short egg-tunnels which diverge and remain in the outer parts of the wood. Intermediate forms were, however, found.

The whole gallery, except the larval chambers, is made by the female. The male follows after the female, taking over the "frass" and pushing it out of the entrance hole. It is probable that the hair fringe on the head of the male is used in this work, but the final ejection of the bore-meal through the entrance-hole is done with the legs. The bore-meal consists of very small particles, minute chips, constituting a white and loose powder. Around badly attacked trunks the boring dust forms a conspicuous ring on the ground.

The entrance hole is circular and attains a diameter of 1.3—1.5 mm. It is furnished with a circular ring or wreath of white chips, which cohere so that the wreath can be removed as a whole. It is then seen that the innerside of this structure has a cup-shaped cavity, probably moulded by the hind-end of the beetle, with a central aperture of 0.5—0.7 mm in diameter, through which the bore-meal is thrown out. Later in summer this wreath falls off. The entrance holes are mostly confined to rough parts of the bark.

Some time at the end of May or in June the picture changes. The ejection of fine loose particles stops and is followed by the appearance of a coherent filament protruding from the central hole in the wreath. These threads may reach a length of 1 cm or more and consist of a mixture of white and brownish particles. They are the external manifestations of the second stage in the life-history of the species, the development of the larvæ. The larva excavates the larval chamber, enlarging the cavity as it grows, and all frass-particles together with the excreta of the larva are pushed out into the egg-gallery.

This process has been studied in detail by Wichmann (1925) and Ch. Hadorn (1933) in the related species *X. lineatus*. The parent beetles now have the task of



transporting this material out, and it seems that the male is especially adapted for this work. The male — which at this period may be found with its head against the external opening — pushes the excreta and bore-meal outwards and finally presses it through the narrow hole in the wreath, thereby moulding the thread. This seems to give a functional significance to the peculiar shape of the head of the male.

More than 100 years ago Th. Hartig (1844) showed that the so-called *ambrosia* found in the galleries of wood-boring scolytids and first observed by Schmidberger (1836) is an almost pure culture of a fungus, on which the larvae feed. These fungi have later been studied by Hubbard, Neger, Schneider-Orelli, Buchner, a. o., and it is now established beyond doubt that they constitute the food of the adults and larvae, and that the uninterrupted removal of bore-meal and excreta from the tunnels is a necessary condition to the normal development of the ambrosia.

When galleries of *Xyloterus domesticus* are laid open, say at the end of June, one may still find full-grown larvae, together with pupae and young adults in the larval chambers. The larva lies in a strongly bent position, so that it is almost spherical in shape. The ambrosia forms a uniform, white layer on the walls of the chamber. The hole between the chamber and the egg-gallery is now closed by a plug of excreta. The pupa is white and shining. It is able to rotate in the chamber (respiration movement?). The young beetle later removes the plug and with its mandibles destroys the thin wall separating the larval burrow from the mother-tunnel, so that an opening is formed in the full breadth of the chamber, i.e. about 1.5 mm.

At first I was puzzled by the fact that young beetles sometimes were lying with their heads in the direction of the egg-tunnel, sometimes opposite, heads against the bottom of the chambers. I found, however, that already Beling (1873) had given an explanation of this (for *X. lineatus*), later confirmed by Hadorf. These authors observed that the young beetles leave the larval chambers to go into the egg-tunnel and probably even out on the surface of the bark. They then return to the larval chambers, and naturally they now turn their heads against the bottom. Hadorf states that the beetles return to eat the larval and pupal cuticles and the ambrosia which has developed during the pupal and first imaginal period. My observations on *X. domesticus* show that this species behaves in a similar way. There is, however, the difference that *X. domesticus* remains in the galleries, where the young adults hibernate, while *X. lineatus*—as shown by Hadorf—goes out again to hibernate in the soil.

Eichhoff (1881) and Løvendal (1898) definitely state that *X. domesticus* has two generations a year, and this has been generally accepted though Beling (1873) and Trédal (1915) only observed one swarming period. During my own studies in three consecutive years, only one animal generation was observed. In the first year, 1941, the fresh entrance holes were not seen till the middle of July, and naturally I thought these to be the work of the second generation. But in 1942 and 1943 the beetles appeared in early May and late April respectively, and in spite of a strict look-out no second generation was observed. There is no doubt, therefore, that in 1941 we were confronted with an abnormally late appearance of the hibernated beetles due to the unusual cold prevailing in the spring. I cannot here go further into this question.

Parasites of *Xyloterus domesticus* were hitherto unknown. In 1942–43 a chalcid, *Perniphora robusta* Ruschka was observed. It penetrates into the galleries and oviposits on the almost full-grown bark-beetle larvae, one egg on each larva. The chalcid larva

lives as an ectoparasite on the host and grows to its full size in about two weeks, thereby killing the host. The parasite larva then goes into a diapause and spends the rest of the summer and the whole winter in the larval stage, not pupating till next spring. *Perniphora robusta* was described by Ruschka in 1923. His material came from Eckstein, who had reared it from a piece of alder wood attacked by no less than five different coleoptera (*Hylecoetus dermestoides*, *Anisandrus dispar*, *Xyloborus saxeseni*, *Xyloterus domesticus*, and *X. signatus* (= *quercus*). The determination of the chalcids found by me is due to Mr. J. P. Kryger, whom I owe my sincere thanks.

### III.

The other species to be discussed here is *Hylecoetus dermestoides* L. of the family *Lymexylonidae*. Here too the imagines show a marked sexual dimorphism. As a rule the male is black, the female yellowish brown, though brown males may be seen. The size varies extremely, in my material from 7—14 mm; the males as an average are smaller than the females. The male has a peculiar maxillary senseorgan, a richly branched appendage, which can be expanded and contracted by blood pressure. The larva is elongate and the ninth abdominal segment has a characteristic rigid outgrowth which is used for ejecting the bore-meal through the hole in the bark. In the first stage larva the outgrowth is represented by a horny shield with two hooked spines; the first stage larva has two groups of 5 ocelli, which are lacking in later instars. While these characters were observed by previous investigators, I was able to find some hitherto overlooked structures of the last larval instar, which allow us to distinguish this stage from the earlier ones. These structures are: 1) the brown and granular cuticle on the front of the head, 2) a brown crescent-shaped cuticular ridge on the side of the head, and 3) behind this the imaginal eye, visible through the semitransparent larval cuticle as a violet spot (fig. 3).

As to the life-history I have been able to make some observations, which supplement what has been known hitherto.

The beetles appear in May or the end of April. The active life of the imago only lasts for 2—4 days. Copulation was not seen, but oviposition was observed in the laboratory. The eggs are placed on uneven places of the bark, either singly or a few together. The egg is about 1.5 mm in length, whitish. The incubation period was about 7 days at a temperature of about 20°. The first stage larvae are apparently negatively phototactic; they hide in crevices etc. and after 3—4 days bore into the bark, forming small holes of a diameter of 0.3—0.4 mm. Later the larva continues into the wood and as it grows, it enlarges the tunnel, but the external opening remains the original size, making it difficult to detect it except at the moment when bore-meal is thrown out.

*Hylecoetus* may live in different species of trees, hardwood as well as conifers, felled stems, stumps or still living injured or diseased trees. In our case it occurred together with *Xyloterus domesticus* in beeches primarily attacked by *Cryptococcus fagi* and secondarily by *Nectria galligena*. While the tunnels have often been described as rather superficial, in our material most tunnels went deeply into the wood, generally with a somewhat winding course. All tunnels are nearly horizontal. The longest tunnels measured about 20 cm, so that the technical injury was considerable. The diameter is almost the same in the whole length, but may vary between 2 and almost 4 mm in different cases.

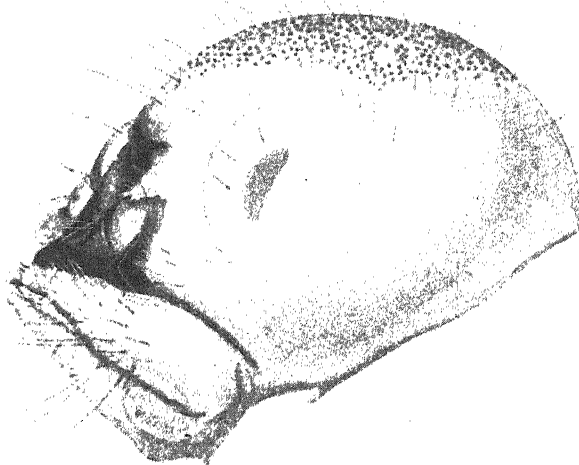


Fig. 3. *Hylecoetus dermestoides* L. Head of larva in last instar. ca. 25 x.

The larva removes the boring dust from the tunnel, and, as originally shown by Neger (1909), just as in *Xyloterus*, the food consists of ambrosia fungi growing on the walls of the gallery (cp. even Schneider-Orelli 1920 and Buchner 1930). I cannot add anything new to this interesting question.

In spring the larva widens the external end of the tunnel at a length of about 10 cm, and now the larva turns with its head against the surface. Then the external opening in the bark is enlarged to the full breadth of the tunnel, i.e. from 2.3—3.8 mm, and a plug of frass is made to close the outer end of the pupal chamber. Thereafter pupation occurs. According to Ratzeburg and Strohmeier the pupal stage only lasts for about 7 days, but the young beetle remains for a few days in the tunnel before it appears.

As to the duration of the development, my observations differ from the statements by previous investigators. Strohmeier (1907), to whom we owe the best study of the biology of this species, holds that the whole life-cycle lasts one year, and Pfeil (1859), Germer (1912), Saalas (1923) and Buchner (1930) are of the same opinion.

It is a well known fact, already mentioned by Ratzeburg (1839), that small, only half-grown larvae are often found in the wood in late autumn and even in spring, when one would expect to find only big larvae (or later stages), if the species really had a life-cycle lasting one year only. Strohmeier considered such larvae to be the offspring of delayed beetles which had laid their eggs later in summer.

The following observations make another explanation more likely.

1. In walnut wood examined by me in January 1944 60 larvae were found. A closer study of these showed that they comprised two groups, 34 of the larvae (group B) possessed the characteristic structures of the last larval instar already

described, while 26 (group A) lacked these characters. The length of the larvae (minus the "tail") was measured, and the curves (fig. 4) show that in spite of great dispersion and over-lapping the tops are well separated. The mean for group A is  $1.03 \pm 0.4$ , for group B  $14.2 \pm 0.4$ . The most reasonable conclusion from these observations seems to be that group B would have pupated in the following spring, while group A would not, a result which seems to favour the idea of a two years' duration of development. The possibility that the A-larvae might have metamorphosed later in summer is improbable, because they comprise 43 per cent of the sample, and if beetles do appear later in summer—as Strohmeier maintains—they are at least very few.

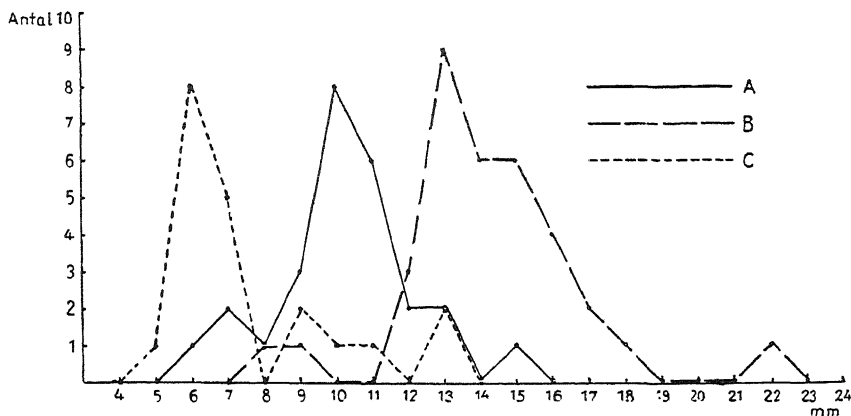


Fig. 4. *Hylecoetus dermestoides*. Length of larvae in groups A, B, and C (cp. text). Ordinate: number of individuals; abscissa: length in mm.

2. In the same month I examined 20 larvae from a beech. These larvae (group C) were surprisingly small, the mean length (— tail) being  $7.5 \pm 0.5$  mm. As only one of these larvae had imaginal eyes etc., group C should be compared with group A. The pronounced difference in size (fig. 4) between the two groups might be explained, if most of the C-larvae were one year younger than the A-larvae. If such be the case the whole development would last three years instead of two, and the small C-larvae might then have originated from eggs laid in 1943, while the few larger C-larvae and the whole A-group might date from 1942, and finally the B-group (and a single C-larva) from 1941. The great dispersion and the fact that the larvae had developed in different trees (beech, walnut) warn, however, against too far-reaching conclusions.

3. In April 1944 22 larvae (group D) were found in a piece of walnut wood, from which a great number of adults had previously emerged. Owing to bad preservation the length of these larvae cannot be compared with those of the other groups. It is important, however, that none of these larvae showed any "pupation characters"; thus they support the conclusion that the development lasts more than one year.

4. On the same material I have measured the width of the head, a character frequently used to establish the number of larval instars (fig. 5). The curves based on these measures also clearly demonstrate that the C-larvae are definitely smaller than the A-groups and thus support the hypothesis that the C-group is on an average a year younger than A. It is more surprising that the B-group (the larvae with

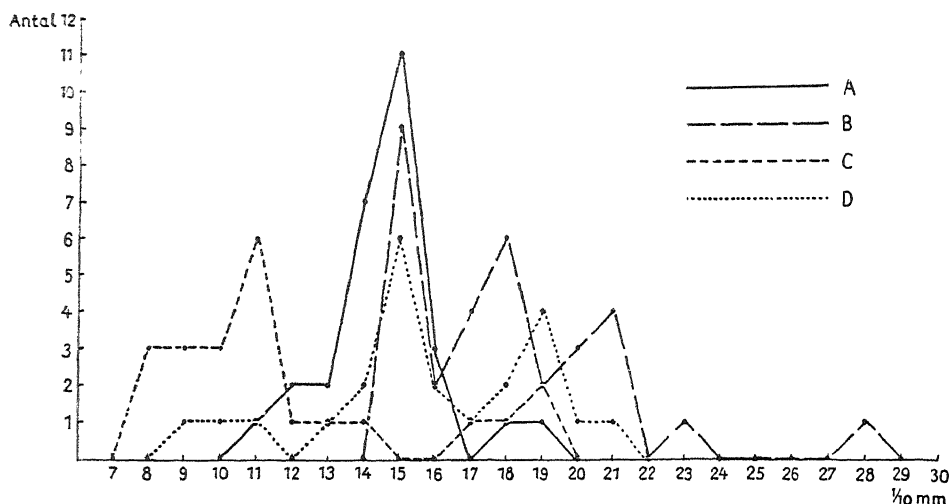


Fig. 5. *Hylecoetus dermestoides*. Head width of larvae in groups A, B, C and D (cp. text). Ordinate: number of individuals; abscissa: head width in 1/10 mm.

“pupation characters”) has a pronounced top in the same region as A and two other tops above this. As a hypothetical explanation I venture to suggest the possibility that pupation does not always occur after the same number of moults.

With regard to the width of the head capsule there is no hesitation in comparing the D-group with the others. As might have been expected the highest top of the D-curve coincides with the A-top, but furthermore the D-curve has a small top in the C-region, possibly representing some larvae which are a year younger than the majority, and a third top corresponding with the big B-larvae. This seems to strengthen the idea of a life-cycle of 3 years and at the same time is in accordance with our interpretation of the B-curve.

Our samples do not comprise the young instars, and for that reason it is not possible to draw any conclusions as to the total number of instars. It may only be said that there are probably more than three instars (cp. van Emden 1944).

5. Some observations in nature agree well, with the results of the measurements of the larvae. I shall only mention the following case which seems to be quite clear. In beech No. 52 (on one of our “experimental plots”) we counted about 100 entrance holes on the lower part of the bole in October 1941. Contrary to expectations no exit holes were found on this part of the tree in the next year, 1942; but in May 1943 about 30 exit holes appeared. These observations show that larvae present in 1941 became adults in 1943. This seems to prove a development lasting two years; but a life-cycle requiring 3 years for all or a part of the larvae cannot be excluded, as the exact date of oviposition in the trunk was not observed. This possibility might agree with the fact that only 30 beetles emerged in 1943 from about 100 tunnels.

Thus from our material it seems safe to conclude that *Hylecoetus dermestoides* needs at least two years and possibly three for its development. Other points are still doubtful and demand further investigation, among these are the following: 1) whether all individuals require three years for their development or some only two; 2) whether

the length of the development is the same in coniferous trees as in hardwood; 3) the number of instars; 4) whether this number is fixed or may vary. These questions ought to be studied on a greater number of larvae originating from dated ovipositions.

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## SECTION VII

A PRELIMINARY ACCOUNT OF THE INSECTS ATTACKING THE DRIED  
ROOTS OF DERRIS AND LONCHOCARPUS

By J. A. Downes

The dried roots of *Derris* and *Lonchocarpus*, woody shrubs of the natural order Leguminosae, are the chief raw materials of the important insecticide rotenone. The rotenone may be extracted by solvents or the roots may merely be ground and used, with suitable diluents, as an insecticidal dust. It is therefore rather surprising to find that these roots are attacked by a wide variety of insects, which are accompanied by their own predators and parasites. In the case of *Derris* this has been known for some years, but the insect fauna of *Lonchocarpus* has not hitherto been studied in detail and only two species have been recorded. Here it is proposed briefly to review our knowledge of the insects attacking *Derris* and to describe the fauna of two consignments of *Lonchocarpus* imported into Scotland from Peru in 1946 and 1947. A more detailed account is being prepared for publication elsewhere.

*Derris* is cultivated chiefly in the East; Malaya, the Phillipine Islands and the Dutch East Indies being important centres. *Lonchocarpus*, since the discovery of its insecticidal properties some twenty years ago, has been grown principally in Peru, Brazil and the neighbouring countries. The roots are dried soon after harvesting and may then be packed in bales for processing in the importing country or may be ground and exported as a dust. Ground roots are not liable to attack by insects.

Our knowledge of the insect fauna of *Derris* is due largely to Miller (1934), who worked in Malaya. He found that twelve species of Coleoptera attacked the roots, and sometimes caused serious damage. Most were wood-boring beetles of the families Bostrychidae, Scolytidae and Cerambycidae, but there was also one species—*Alphitobius laevigatus* F. (Tenebrionidae)—that is characteristic of stored foodstuffs. The more abundant and harmful species were the Bostrychids, *Sinoxylon anale* Lesne, *Xylopsocus capucinus* F., *Dinoderus minutus* F., *D. bifoveolatus* Woll. and *Xylothrips flavipes* Illig. Associated with them were the predatory beetles *Tenebroides mauritanicus* L. (Ostomidae) and *Cylidrus wallacei* Thoms. (Cleridae), and the predatory Hemipteron *Peregrinator biannulipes* Montr. (Reduviidae).

Later, Lever (1943) found that in Fiji *Derris* roots were attacked by *Xylothrips religiosus* Boisd. and by *Minthea rugicollis* F. (Lyctidae), one or other of which was parasited by a Chalcid. *Sinoxylon conigerum* Gerst. has been found in the United States in *Derris* imported from the East Indies (U.S.D.A. 1936) and several of the insects listed by Miller have similarly been intercepted. *Ptinus fur* L. another stored food beetle, has been found on *Derris* held in a warehouse in the United States (Roark, 1939).

The only two insects reliably recorded from *Lonchocarpus* are *Dinoderus bifoveolatus*, which does heavy damage to the roots in Peru (Wille, 1934) and has also been imported with them into the United States (U.S.D.A. 1942), and *Xyleborus confusus* Eich. (Scolytidae) (U.S.D.A. 1937). The consignments recently inspected in Scotland yielded,

however, no fewer than thirty-one species of insects, as well as two arachnids. *D. bifoveolatus* was the most abundant species and it was accompanied by *Eccoptogaster dimidiatus* Chap. (Scolytidae) and five other wood-boring Coleoptera. *Araecerus fasciculatus* Degeer (Anthribidae), usually found in coffee, cacao, maize, etc. was also rather common and its larva was behaving as a primary wood-borer.

On the whole wood-boring beetles were less in evidence in these *Lonchocarpus* roots than in *Derris*. In contrast, species characteristic of stored foodstuffs occurred in much greater numbers, and included *Alphitobius laevigatus*, *Tribolium castaneum* Herbst., *T. confusum* J. du V. (Tenebrionidae), *Ahasverus advena* Waltl., *Monanus concinnulus* Walk., three species of *Laemophloeus* (Cucujidae) and two of *Carpophilus* (Nitidulidae). All stages of these beetles were found in the burrows made by the primary wood-borers or in accidental cracks in the roots, but their real source of food was not determined. Predators were represented by *Tenebroides mauritanicus*, *Peregrinator biannulipes* and a pseudoscorpion.

Thus both materials can support a rich insect fauna composed of wood-borers, of species characteristic of stored foodstuffs and of predators or parasites. In *Derris* the wood-boring element, and in *Lonchocarpus* the stored food element, is particularly well developed.

These faunas can also be analysed in another way. Most of the insects already mentioned are well known to have become widely distributed as a result of international trade in the many commodities they inhabit. Certain other forms, however, still have restricted distributions, which extend little beyond their natural ranges. In this category there are: on *Derris*—*Sinoxylon rugicauda* Lesne, *S. mallacanthum* Lesne (Bostrychidae), *Perissus laetus* Lameere, and *Pterolophia melanura* Pasc. (Cerambycidae); on *Lonchocarpus*—*Eccoptogaster dimidiatus*, *Chramesus tumidulus* Blanford (Scolytidae), *Achryson surinamensis* L. (Cerambycidae), *Laemophloeus castaneipennis* Grouv. and *L. punctatus* Lec. (Cucujidae).

The reasons why these species are not more widely distributed are probably of two kinds. The five Cerambycidae and Scolytidae are thought to attack the roots before they are dried, and, though the adults are able to emerge from the roots after drying and storage, they cannot initiate a second generation on dried materials such as would be found in a warehouse. Thus when transported to another country they would usually be unable to reproduce. The species of *Sinoxylon* and *Laemophloeus*, on the other hand, can probably reproduce successfully under warehouse conditions, as do many of their congeners. For these it must be supposed that, as *Derris* and *Lonchocarpus* roots have entered international trade only recently, and in relatively small quantities, they have not yet had sufficient opportunity to become effectively distributed and established in countries remote from their native regions.

This illustrates, perhaps, some aspects of the process by which the more or less cosmopolitan and polyphagous fauna of stored products insects has developed. A commodity newly introduced into international trade will harbour insects native to the region where it was grown. Some of them may be unable to live under warehouse conditions and will be eliminated. Others may be able to adapt themselves and will in due time become established in storage places in distant parts of the world and may often spread to other kinds of stored commodities. Equally, the new commodity may be attacked by species that are already widespread, and this attack may occur at any stage during production and storage when the commodity is exposed to populations



of these insects. In the present cases many of the recognized stored food insects attacked the roots in the country of origin soon after drying, but the infestation *Ptinus fur* on *Derris* was probably acquired after arrival in the United States.

#### SUMMARY

1. A general account of the insect faunas of the dried roots of *Derris* and *Lonchocarpus* is given.
2. Using these cases as examples, some of the processes by which the cosmopolitan fauna of stored products insects has been built up are discussed.

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## METHODS OF SPREAD OF STORED PRODUCTS INSECTS AND ORIGIN OF INFESTATION IN STORED PRODUCTS

By J. A. Freeman

### *Introduction.*

Those responsible for the control of insect and mite pests of stored products must have regard for the fact that pests are constantly being carried from one country to another in various ways. Accurate knowledge must be available of the pest already established, of the means by which other pests are likely to be introduced and spread and of their biology and habits. The latter is of particular importance in assessing the ability of the introduced species to establish itself and hence whether a particular quarantine is necessary. This paper deals with the various methods by which stored products insects are dispersed, i.e. with one aspect of this general problem, based on experience in the United Kingdom during the past ten years.

### *Distribution and Establishment.*

Many pests of stored products are cosmopolitan in distribution, their original homes being now only conjectural. Several species have, however, been dispersed during relatively recent times and provide examples of how rapid such dispersal may be. Zacher (1939) gives, inter alia, information regarding the spread of *Ephestia kühniella* Zell., *Niptus hololeucus* Fald., *Ptinus tectus* Boield., and *Trogoderma granarium* Everts.

*Ephestia kühniella* was found first as a pest of flour mills in Saxony in 1877 and was recorded from flour mills in Europe and North America during the next twenty years. *Niptus hololeucus* spread over Europe during the fifty years following its discovery in Turkey in 1835; *Ptinus tectus*, whose original home was Tasmania, was first found in England in 1892; between 1901 and 1904 it was found in a number of English towns and by 1916 it had spread to Ireland and Europe. *Trogoderma granarium*, an important pest of grain in India, established itself in England during the 1914-1918 war.

These species were able to find conditions suitable for establishment in the United Kingdom; *Ephestia kühniella*, *Niptus hololeucus* and *Ptinus tectus* have no difficulty in passing the winter in unheated warehouses; although the larvae of *Trogoderma granarium* can survive the winter in the absence of artificial heat, the species only breeds up to epidemic proportions under the warm, dry conditions found in maltings. Some of the species introduced into the United Kingdom, in merchandise and otherwise, may find it possible to breed under conditions of unheated storage; others, however, may only be able to establish themselves under special conditions e.g. in heated buildings or in limited areas of the country. The constant introduction of species may however lead to the selection of individuals capable of resisting adverse conditions and so result in the extension of the area of distribution of a particular species. It is not possible to neglect a particular species merely because it cannot survive the winter in unheated buildings; it may give trouble during the warm months of the year or it may cause changes in the commodity itself (e.g. heating of grain) which may enable it to continue breeding during the winter. There has been a number of instances where *Rhizopertha dominica* F. and *Calandra oryzae* L. have survived the winter in heating

grain in the United Kingdom, and where even such species as *Corcyra cephalonica* Staint., *Tribolium castaneum* Herbst., and *Necrobia rufipes* Deg., have continued to breed during a cold winter in heavily infested and heating groundnuts stored in an unheated warehouse. The introduced species may not only have to resist an adverse climate. Even if it is capable of breeding under the particular conditions, it may have to compete with other species which already occupy the same ecological niche. Thus Stroyan (1946) has pointed out that in Indian flour mills, *Corcyra cephalonica* Staint. and occasionally *Ephestia cautella* Walk. are found breeding in machinery, whereas *Ephestia kühniella* Zell., the "mill moth" of Europe and the United States of America, is absent.

### Dispersal.

The means by which insects and mites are dispersed may be considered under two main headings. First there is local dispersal, within a warehouse or its vicinity; second there is long distance dispersal, generally in the course of trade.

#### a) Local dispersal.

Under temperate conditions few of the species of beetles which infest stored products fly at all readily and local dispersal is mainly by walking. Some of the most important species effect local dispersal entirely in this way, as they are incapable of flight, e.g. *Ptinus tectus* Boield and *Calandra granaria* L. Disturbance of the foodstuff may often induce the insects living in it to become very active so that the surface of the grain and of the walls and floor of the room in which it is stored, will rapidly be covered with moving beetles. This has been observed for such species as *Calandra granaria*, *Calandra oryzae*, *Rhizopertha dominica*, *Oryzaephilus surinamensis* L. and *Laemophloeus* spp. Moths and some species of beetles disperse locally by flight. *Calandra oryzae*, *Sitotroga cerealella* Ol. and *Laemophloeus minutus* Ol., have been recorded attacking rice in the field in the southern states of the United States of America (Douglas 1941). The writer has observed *Calandra oryzae* (large form) landing on the roof of a granary in England after a flight to a height of about 30 meters from a cargo of maize being discharged from a ship on the other side of the dock, about 100 meters away. It has been shown that samples of grain at least 150 meters away from the nearest source of moths, became infested by *Ephestia elutella* Hübner (Waloff and Richards 1946 p. 303). The same authors observed that moths readily flew out of the windows of a warehouse, particularly during the flight period at dusk. These observations provide one possible explanation of the origin of infestation by *Ephestia elutella* in Canadian wheat stored from 1941 onwards in London riverside warehouses. It is known that in most instances the warehouses had not previously held infested commodities, but had been used for many years for rubber and tea, and that the grain and the bags in which it was held were also free from original infestation by this species. Other species which are known to fly readily are *Tenebrio molitor* L., and *Hofmannophila pseudospretella* St.

Local dispersal may occur by wind currents. This can be readily observed in any warehouse holding stocks which are heavily infested by mites which are easily blown by the wind, particularly in the hypopal stage. Under favourable conditions insects may also be dispersed locally in this way. During the summer of 1941 it was found that certain trainloads of Canadian flour sent inland for storage after discharge in Hull from a particular ship, were infested by adults of *Tribolium castaneum*, *Lasio-*

*derma serricorne* F., *Tenebroides mauritanicus* L., and *Tribolium confusum* Duv. Inspection of the flour in the holds of the ship shewed it to be clear of infestation, but a ship at the next berth, across a quay, was discharging cotton seed cake, heavily infested by a wide variety of insects, including those found on the flour. It is considered that the insects were drifted by the wind from the cake being unloaded from one vessel across to the flour lying in the railway trucks.

Both mites and insects may be dispersed on the clothing of persons working in infested buildings or in infested cargoes. There is little doubt that mites are easily carried from room to room by persons who have walked through mite "dust" on the floor; beetles will readily hide in clothing, finding their way into the shoes and folds in the clothing of those in contact with the infested materials. Carriage of mites may occur on insects, rats and mice. Mite hypopi have been observed on *Tenebrio molitor* and *Lathridiid* beetles by staff of the Ministry. Hughes (1948) refers (page 126) to the spread of *Macrocheles carinatus* Koch (*Acarina*; *Parasitiformes*) by clinging to flies and beetles and the hairs of small mammals. Solomon (1943) quotes evidence from various authors of the dispersal of mites by various methods.

b) *Long Distance Dispersal.*

Many stored products pests are not specific to one kind of commodity but are able to attack a number. Thus *Ephestia elutella* can breed on a wide variety of foods such as wheat, maize, oilseeds, tobacco, cacao, animal feeding stuffs, whereas *Bruchid* beetles are confined to leguminous seeds. Many pests can exist for long periods without food, may have long resting periods in the life cycle, or may penetrate into non-food commodities at some stage, e.g. the larvae of *Dermestes maculatus* Deg. The carriage of pests for long distances is therefore not dependent on the ability of the insects to continue breeding in some favourable material; they may be carried purely as passengers in some material which they cannot attack.

On land the dispersal of insects may occur slowly by methods of local dispersal or over long distances by the various methods used for the transport of goods e.g. railway trucks, road lorries, canal and river barges and aircraft. Between countries separated by water such carriage occurs in ships, both ocean going and short sea types, in railway trucks on train ferries, and in aircraft.

The extent to which insects are in fact dispersed in this way is shown by the evidence obtained at United Kingdom ports during the past few years. Nearly every cargo of food and other commodity liable to infestation has been examined in ships arriving at United Kingdom ports since 1942 and records have been kept of the numbers of species of insects and mites found. The main commodities examined consisted of cereals, oilseeds and dried fruit. The level of infestation in commodities from temperate countries was low; commodities from India, Africa and South America were generally heavily infested and these countries were the main centres of dispersal of pests. This subject is discussed in greater detail with diagrams elsewhere (Freeman 1948 a, b).

Between 1944 and 1946 a total of some 190 species of insects and mites was recorded; the most common species were *Tribolium castaneum* (58 occurrences per 100 infested ships inspected); *Ephestia cautella* (37), *Necrobia rufipes* (33), *Tenebroides mauritanicus* (32), *Laemophloeus* spp (25), *Oryzaephilus mercator* Fauv. (22), *Corcyra cephalonica* (20), *Ephestia elutella* (20), *Calandra oryzae* (19) and *Plodia interpunctella* Hb. (18). It is of some consequence to note that of these only *Tenebroides mauritanicus*,

*Ephestia elutella* and *Plodia interpunctella* can survive normal winter conditions in unheated warehouses in the United Kingdom; *Ephestia cautella* and *Calandra oryzae* may do so under certain conditions. The established population is thus being constantly reinforced by introduced species, not only of kinds which are able to establish themselves, but also of types which cannot do so unless they find suitable conditions. It is also of interest to note that some of the most common established pests such as *Calandra granaria* (8), *Oryzaephilus surinamensis* (15) and *Tyroglyphus farinae* L. (8), were introduced relatively much less frequently; some widespread pests e.g. *Ptinus tectus*, *Ephestia kühniella*, *Tenebrio molitor* and *Dermestes lardarius* were hardly ever recorded on commodities on import, although the first two are known to have been so introduced originally.

It is as important to know which pests are being introduced occasionally in small numbers as those which are most frequent, for the former may be pests elsewhere and may be capable of establishing themselves in the United Kingdom. It has already been pointed out that *Ephestia kühniella* and *Ptinus tectus* were only recorded a few times during the period under review. It is therefore of interest to note that a large number of species were found which had only seldom been recorded previously in the United Kingdom, were new records; or were even new to science. Some examples follow:—

a) *Few previous records.*

Species	Country of origin	Reference
<i>Falagria concinna</i> Erichson (Coleoptera, Staphilinidae)	Brazil, Canada	Hinton 1947 a
<i>Litargus balteatus</i> Lec. (Coleoptera, Mycetophagidae)	Argentina, U.S.A.	Hinton 1947 b
<i>Sitophagus hololeptoides</i> Castelnau (Coleoptera, Tenebrionidae)	W. Indies	Hinton 1944
<i>Lyctus africanus</i> Lesne (Coleoptera, Lyctidae)	India, Australia	Hinton 1947 b
<i>Carpophilus obsoletus</i> Er. (Coleoptera, Nitidulidae)	Ceylon	Hinton 1943 b
<i>Ephestia calidella</i> Gn. (Lepidoptera, Phycitidae)	Cyprus (locust beans)	Ministry record.
<i>Ephestia figulilella</i> Gregs. (Lepidoptera, Phycitidae)	Australia (dried fruit)	Ministry record.

b) *New records.*

<i>Attagenus gloriosae</i> Fabr. (Coleoptera, Dermestidae)	India	Hinton 1943 a
<i>Attagenus alfieri</i> Pic. (Coleoptera, Dermestidae)	India	Hinton 1943 a
<i>Gonocephalum prolixum</i> Er. (Coleoptera, Tenebrionidae)	West Africa	Hinton 1947 b
<i>Carpophilus maculatus</i> Murray (Coleoptera, Nitidulidae)	Ceylon	Hinton 1943 b
<i>Ptinus villiger</i> Reitt.	Canada	Hinton 1944 and later
<i>Ptinus raptor</i> Sturm. (Coleoptera, Ptinidae)	Canada	Ministry records

c) *New species.*

*Tyrtaeus dobsoni* Hinton  
(Coleoptera, Colydiidae)

India

Hinton 1946

It is probable that a number of these and other introduced species will be unable to establish themselves. Not only is the climate unsuitable for some, but in the case of certain species, e.g. *Ptinus raptor* and *Ptinus villige*; active steps were taken, by insecticide spraying and fumigation, to eradicate those individuals which had been introduced. A few may find conditions suitable and they may be expected to become a permanent feature of the stored products insect population, although it may be some time after the original introduction before they become noticeable. There are records, in the history of deliberate introduction of biological control species, of failure to recover during the first few years after release, only for the insect to appear in larger numbers later.

All the introductions referred to have taken place in cargo in ships. It is not considered that aircraft at present represent a significant source of introduced species. A few test inspections of aircraft have been carried out and in the course of a special survey carried out during August 1947 at Croydon, Heathrow and Northolt airports, only very few stored products insects were found, including *Carpophilus hemipterus* L., *Tribolium castaneum* and *Cryptophagus* sp.

*Means of carriage and dispersal.*

The principal means of carriage of stored products insects is on the commodities in which they are breeding. The insects and mites do not however remain there; they may migrate into other commodities in the same transport; after the goods have been removed the insects and mites may remain in the structure, perhaps breeding in residues, ready to infest subsequent cargoes, which may be loaded in another country. Special attention is directed here to the problems of cross and residual infestation and infestation caused by the use of infested bags and dunnage.

a) *Cross Infestation.*

Cross infestation may be defined as the infestation of one commodity by the movement to it of insects and mites from another. This occurs whenever goods of different kinds or different origin are stored together in the same part of a transport unit; e.g. in the holds of ships and river craft. Such cross infestation occurs most readily when commodities of different kinds are placed into the same holds, sometimes at different stages of the voyage. In this way, insects which have been picked up at one port may be landed eventually with goods at another, even though the latter goods were not infested with that particular species when they were loaded. It would seem that a certain proportion of the infestation of cocoa beans from West Africa (particularly *Tribolium castaneum*), is due to carriage with groundnuts. South American flour imported during 1944 in mixed stowage with grain, feeding stuffs etc., was frequently infested with insects not normally found in flour, such as *Calandra* spp., *Rhizopertha dominica*, *Necrobia rufipes*, etc., due to cross infestation either during the voyage or during storage prior to loading.

The extent of cross infestation is much more marked when insects spread from infested commodities to others which are either of a kind on which the particular species cannot breed e.g. *Calandra* spp. on bones, or onto commodities such as cased goods, tea, jute and hemp, on which the insects cannot live but are merely carried

as passengers. There has been a number of instances of severe infestation of tea in chests by larvae of *Trogoderma granarium* and *Ephestia cautella*, which had migrated during the voyage from India to Britain from groundnuts stored in the same holds. One ship, inspected in December 1941, had loaded canned jam in corrugated board cases and bagged maize in South Africa and cottonseed at Alexandria. *Tribolium castaneum*, *Oryzaephilus surinamensis*, *Sitotroga cerealella*, and *Hymenoptera* (parasites of the beetles and moths) were found in the corrugations of the cardboard, having migrated from the cottonseed and the maize. There are other examples as where *Dermestes maculatus* larvae had moved from hides and bones and burrowed into the wood of cases of tinned meat on the voyage from South America and had been carried far inland into Britain before being discovered. Another example is of canned milk in wooden cases, which arrived in the United Kingdom from India during 1946. *Dermestes maculatus* larvae had migrated from bones into the woodwork; there were also large numbers of *Necrobia rufipes* from the same source on and in the cases.

b) *Residual infestation.*

A frequent method of dispersal of pest and origin of unexpected infestation is residual infestation, which may be defined as infestation resulting from attack by insects which have remained in the structure of the store, vessel or vehicle after the removal of a previously infested commodity. There are examples of residual infestation in railway trucks, road lorries, canal barges and ocean vessels. Where such infestation persists in residues in which insects can breed more or less indefinitely the infestation may become endemic.

An infestation in road transport in England has been described by Freeman (1948 b). In this case flour was loaded into an open platform lorry and then sheeted with tarpaulins. On arrival at the food factory some 60 miles away, the flour was found to be infested by larvae of *Trogoderma granarium*. These insects had emerged from under the floor boards of the lorry, which had not carried any goods from which such insects could have come for some six weeks previously.

Residual infestation in barges is not uncommon. The following examples illustrate the nature of the problem. In London during 1947 some 200 tons of freshly milled flour became so heavily infested with *Tribolium castaneum* that it had to be used for manufacture of animal feeding stuffs. The barge had been used for carrying cottonseed and the two subsequent cargoes of cement and coal had not affected the insect population. It seems probable that many of the *Tribolium* had remained alive in the tarpaulins covering the hatches.

In Hull, during June 1948, newly imported Canadian flour which had become infested with *Tribolium castaneum* and *Oryzaephilus surinamensis* during carriage in barges, had to be fumigated. One barge had carried previously Burmese rice bran heavily infested by *Tribolium castaneum* and the other two had carried South American linseed cake infested by *Oryzaephilus surinamensis*.

Long distance dispersal of insects takes place owing to residual infestation in the holds of ships. The insects may merely remain hidden in the structure of the ship; for example, beetles under flaking paint; may be in a resting stage: for example Lepidopterous larvae in cocoons; or, more serious, insects may continue to breed in residues of previous cargoes. Such residues may be so well protected inside pipe casings or other enclosed parts of the ships that the insects have been known to survive fumigations of the holds which have been otherwise quite satisfactory.

The following examples of residual infestation in ships will illustrate the extent of the problem.

a) *Residual infestation leading to direct infestation of a subsequent cargo.*

Manitoba Wheat and Canadian flour usually arrive in the United Kingdom free from insects. There has been a number of instances when this was not so and in nearly every case it has been possible to demonstrate that the infestation was due to residual infestation. For example:—

*Ship "A"* From Vancouver to U.K. in 1946, with Manitoba wheat.

Infestation discovered in the wheat included *Laemophloeus* spp., *Tribolium castaneum*, *Necrobia rufipes* and *Dermestes ater* Deg.

The previous voyage was from the Philippines to Vancouver with copra.

*Ship "B"* From Montreal to U.K. in 1946, with Canadian flour.

Infestation found in the flour included *Calandra oryzae*, *Laemophloeus* spp., *Plodia interpunctella*, *Tribolium* spp., *Sitotroga cerealella* and *Ptinus tectus*.

The previous voyage was from Argentina to Montreal with maize.

b) *Residual infestation established in residues of previous cargoes.*

Residues may be found in all parts of the holds, but one of the most common places is on girders supporting the decks. These are inaccessible without scaffolding once a cargo has been discharged and are frequently not cleaned for long periods. As each bulk cargo is carried so a little is added to the layers of residues and the history of ships may often be traced from an examination of the residues. The subject has been dealt with in greater detail elsewhere (Freeman 1948).

Examples of this type of residual infestation are as follow:—

*Ship "C"*. On arrival in the United Kingdom from West Africa with a cargo of palm kernels a number of typical wheat pests were found in addition to the usual palm kernel insects. Careful inspection shewed the presence of large quantities of Australian wheat in various parts of the holds and in this wheat were breeding *Tribolium confusum*, *Latheticus oryzae* Waterh., *Calandra oryzae* and *Tenebroides mauritanicus*. Reference to the past history of the ship shewed that the last cargo of wheat had been carried four years previously. A cargo of flour brought to the United Kingdom twelve months before the palm kernels had been infested from the same infested wheat residues, but the origin of the infestation was not detected at that time.

*Ship "D"*. A vessel carried wheat from Australia to North Africa in March 1944. She then went to India and loaded tea, linseed, bones and myrobalans for the United Kingdom. Owing to the discovery of a number of typical grain insects on the myrobalans a careful search of the ship was made and wheat spillage was found in which were breeding *Tribolium castaneum*, *Rhizopertha dominica*, *Calandra oryzae*, *Laemophloeus* sp., *Sitotroga cerealella*, *Latheticus oryzae* and *Ephestia cautella*.

These instances could be repeated many times from the records obtained since 1942. (An illustrated diagram is given in Freeman (1948 b).) It is clear that in the instance of Ship "C" the insects established in the wheat might have been carried round the world several times since the original infestation of the ship. Such carriage is even more important as a means of dispersal for domestic pests which establish themselves in the accommodation of ships; such are cockroaches and ants (particularly *Monomorium pharaonis* L.). There are records of these insects being carried ashore on cargo, ships' stores, passengers' and crews' baggage and clothing.



c) *Infestation arising from the use of infested containers.*

The principal container used for the transport of foods and other materials liable to infestation is a bag of some kind. The most common material is a jute cloth (hessian), but other materials such as cotton cloth and paper are also used. Under the classification of container one may also consider the problem of "dunnage" i.e. materials used in the packing of goods to prevent contact with the floor or walls of the building or vessel.

Bags are often used many times before they wear out. In fact much grain is carried in Britain in sacks which are hired out for this purpose by sack hiring firms. Flour, too, is mainly distributed from flour mills in the millers' own sacks, which are returned to the mill for refilling.

There follow some examples of the manner in which bags act as agents in the dispersal of insects.

1) *Use of second hand bags inland.*

Most oilseeds arrive in Britain in bags. After crushing of the seeds, the cake, which has been rendered free from infestation in the process, may be packed into the original bags from which the groundnuts have been emptied. The cleaning process to which the bags are subjected is not sufficient to kill the insects and there are many instances of cake being infested by *Tribolium castaneum*, *Ephestia elutella*, *Ephestia cautella* and *Corcyra cephalonica* in this way. Cocoa and oilseed bags have been used for the storage of wheat and in one case an outbreak of *Ephestia elutella* on home grown barley could be traced to the use of infested cocoa bags.

2) *Use of second hand bags on ships.*

Two ships carrying wheat from Canada to the United Kingdom during late 1946 were found to be harbouring *Ptinus villiger* and *Ptinus raptor*. These insects had clearly been introduced with second hand animal feeding stuffs bags used for the layers of bagged wheat covering the bulk wheat in the hold. It has already been pointed out that these species are not established in the United Kingdom, although they are pests in Eastern Canada.

3) *Use of returnable sacks.*

Many inspections of sacks returned by bakers to flour mills have shown that they are often infested by *Ephestia kühniella*, *Tribolium* spp., *Gnathocerus cornutus* F., *Oryzaephilus surinamensis*, *Ptinus tectus*, *Tenebrio molitor* and *Dermestes lardarius*. Although in many instances these insects may have been sent out (perhaps in an immature stage) with flour from the same mill, the fact that millers receive not only their own but other millers' bags makes this a means of carriage of insects from mill to mill. Since bakers too receive flour from more than one mill, a clean mill may become indirectly infested from a dirty one by the intermediary of the bakehouse flour store. Grain sacks not infrequently harbour insects such as *Calandra granaria*, *Calandra oryzae* and the spun larvae of cocoon spinning insects such as the *Ptinid* beetles, and the moth *Endrosis sarcitrella* L. (a particular pest of peas). The rapid spread of *Ptinus tectus* already referred to probably took place largely in this way by carriage in cocoons spun to bags.

4) *Carriage on other types of container and on dunnage.*

Migration of insects on to corrugated cardboard containers has already been mentioned as has the penetration of wooden cases by *Dermestid* beetles seeking pupation

sites. True woodboring insects are dispersed by the use of infested timber for the manufacture of packing cases. Thus there are many records by the Ministry staff of the introduction of *Lyctus brunneus* Steph (and its associated predators *Paratillus carus* Newman and *Tarsostenus univittatus* Rossi) and *Lyctus africanus* Lesne (Hinton 1947) from Australia; of *Heterobostrychus aequalis* Waterh., *Minthia rugicollis* Walk (Hinton 1947), and *Sinoxylon conigerum* Gerst., in tea chests, cashew kernel crates and other wooden cases from India. In addition to the spread of true wood boring insects in this way it has been observed that food infesting forms will often seek shelter in the tunnels made by the former insects. Such species as *Tribolium* spp., *Gnathocerus cornutus*, *Oryzaephilus surinamensis*, *Latheticus oryzae*, *Lepidopterous* caterpillars seeking resting and pupation sites, and *Ptinid* larvae seeking pupation sites have all been so observed.

The dunnage used in ships for the protection of cargo may be hessian or paper sheets, temporary or permanent wooden bulkheads (as required for the carriage of bulk cargoes) bamboo poles and matting made of split bamboos or other material. The last named has been found to harbour a number of wood boring insects, including *Lyctoxylon japonum* Reitt (Hinton 1947) and it is as liable as other tunnelled wood to be invaded by food pests. There is always the danger that dunnage of a type which provides folds or crevices (hessian sheets, wooden timbers, matting) may harbour insects from an infested cargo. Insects found on such dunnage include *Tribolium castaneum*, spun larvae of moths, and particularly the larvae of *Trogoderma granarium*, whose habit of massing in small cracks is well known.

#### 5) Use of infested packing materials.

During 1946 a quantity of mixed pickles in glass jars carried from Australia to Britain, was found to have been packed in rice husks to prevent breakage. The rice husks were harbouring a very heavy insect population including *Alphitobius laevigatus* Fab., *Alphitobius diaperinus* Panz., *Calandra granaria* L., *Calandra oryzae* L., *Carpophilus humeralis* F., *Carpophilus hemipterus* L., *Carpophilus dimidiatus* Fab., *Carcinops 14-striata* Steph., *Caenocorse ratzeburgi* Wiss., *Caenocorse subdepressus* Woll., *Dermestes maculatus* Deg., *Laemophloeus* sp., *Lophocateres pusillus* Klug., *Latheticus oryzae* Waterh., *Periplaneta americana* L., *Oryzaephilus surinamensis* L., *Rhizopertha dominica* F., *Tenebroides mauritanicus* L., *Tribolium castaneum* Hbst., *Tribolium confusum* Duv., *Somotrachus unifasciatus* Dejean., and *Rhabdepyris zeae* T & W. The whole consignment had to be fumigated but it will be observed how wide a variety of insects was introduced in this accidental manner.

#### Conclusions.

The evidence presented shows that insect pests of stored produce are being constantly carried about the world in the course of trade. Not only are the insects distributed in the commodities in which they are breeding, but also on other goods as passengers by cross infestation in transport and warehouses. Transport vehicles may also cause the indirect dispersal of insects by harbouring them in residues of previous cargoes, in second hand bags and in dunnage. In addition to carriage on goods, containers and transport, insects may spread within and between warehouses by walking, by flight, by wind currents and by carriage on man and animals.

Many of these insects are being carried to conditions under which they are unlikely to be able to multiply owing to unfavourable climatic conditions, unless they are able

to find local micro-climates, which are suitable. Thus for example the *Blatella germanica* L., and *Periplaneta americana* L. carried ashore to unheated warehouses in cased goods returned to the United Kingdom from India during 1947 would be unlikely to establish themselves unless they could find their way to buildings heated during the winter. On the other hand there is the history of establishment of the introduced species *Ptinus tectus*, *Ephestia kühniella* and *Trogoderma granarium*. Hinton (1947 a) has drawn attention to two species of beetles, *Euophryum confine* Broun (Coleoptera, Curculionidae) and *Falagria concinna* Er (Coleoptera, Staphiliniidae), which have established themselves in the United Kingdom within the past few years. Others which have been intercepted from time to time in stored products may be able to find a niche.

To the academic entomologist these observations may be of interest as throwing some light on the mechanism of dispersal, but to the economic entomologist each of these various methods of dispersal presents a problem of prevention and control, in addition to the problems already presented by the indigenous insect pests. In Britain such control is exercised by the inspection of ships on arrival in the United Kingdom, by the treatment of infested commodities when necessary and by the treatment of the empty holds of ships where continued use might endanger subsequent cargoes. In Canada control is exercised by the issue of certificates of fitness of ships' holds for the loading of cereals and cereal products only after inspection and treatment when necessary. The prevention of spread of infestation by the use of infested containers, especially bags, is carried out by the establishment of fumigation facilities and, in the case of flour mills, by encouraging the use of non-returnable bags or the installation or more efficient methods of cleaning and the disposal of dust so removed (Freeman and Turtle 1944). It is not expected, however, that port quarantine will serve to keep out all the species which seem likely to be able to establish themselves and constant survey is carried out so that new pests may be eradicated before they can build up large populations. The extent to which cross and residual infestation occurs in ships makes the problem of exclusion of undesirable insects very complicated, as one must not only take account of commodities in which insects may breed, but also other non-infestible goods on which they may be carried. The prevention of spread of insects can only effectively be dealt with, in the long run, if the principal exporting countries take steps to ensure that the goods are clear of infestation when they are shipped; this will then give the importing countries the opportunity of dealing with their indigenous populations without constant reinforcement from abroad.

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## SOME RESEARCH PROBLEMS IN THE FIELD OF STORED PRODUCTS ENTOMOLOGY

By *G. V. B. Herford*

The Pest Infestation Laboratory was set up in 1940 to deal with the problem of the infestation of stored foodstuffs by insects and mites. Although the original demand for such a service arose from peace-time conditions, the new Laboratory had to face war-time problems of food storage\* from the very outset of its career.

Consequently, the whole of our attention had to be devoted to work of immediate practical importance and longer range basic research had to be omitted or reduced to a minimum.\*

On the biological side, the most pressing problem was the safe storage, in very large amounts, of so-called security stocks of wheat. The long-term storage of these grain stocks provided every opportunity for the undisturbed development of insect infestation, and it was therefore necessary that incoming cargoes should be adequately inspected and sampled, and, when necessary, should be disinfested before being put into store.

The Laboratory's first task was to work out satisfactory methods for doing this.

Sampling equipment was developed, and a method was evolved for estimating the degree of infestation in the collected samples. For this purpose, the amount of carbon dioxide produced in a given time by the insects or mites in a sealed sample was used to give an over-all indication of the extent of the infestation.

At the same time, biological work in the laboratory and in the field threw light on the distribution of grain-infesting insects and demonstrated the fact that insect attack alone could—and frequently did—cause grain to become heated by the development of local and rapidly expanding "hot-spots". Such heating, initially caused by insect attack, can result in the spoilage of large quantities of grain.

The problem of disinfesting insect-ridden grain appeared to be best solved by fumigation, and methods have been worked out for the safe use of gases such as ethylene oxide, hydrogen cyanide and, more recently, methyl bromide.

The very cautious attitude taken by the authorities in Great Britain regarding the use of fumigants on foodstuffs meant that a great deal of research had to be carried out by the Laboratory before grain fumigation could be used on a commercial scale. Thus it was necessary, for each fumigant, to investigate the extent to which the gas was taken up by the grain or other foodstuffs to be treated and the extent to which it was released on airing. In addition, feeding tests were conducted, in which animals were given rations containing known proportions of sorbed fumigant, and studies were made under practical conditions, of the penetration and distribution of the fumigants when applied in different ways and under different physical conditions.

The possibility of using dusts for the protection of clean foodstuffs stored in infested premises has been explored, and considerable attention has been given to the use of insecticides for the disinfestation of warehouses, but as both of these investigations are included in the paper by my colleague Dr. Parkin, I will not attempt to deal with them here.

It is our endeavour now to promote a better balance in our research programme by including a larger proportion of longer range work than has hitherto been possible,

for without a "leaven" of research of this type no true scientific progress is possible.

Today I propose to talk a little about some of the new lines of work which we regard as important. Some have already been started, others are still held up, pending the recruitment of suitably trained staff.

1. Let us look first at the biological side of the work. We have, during the past eight years, spent much time accumulating factual data on the biology of certain of the more noteworthy pests of stored food, especially of stored cereals. We have studied the bionomics of the two *Calandra* species in the laboratory and in the field, and the same has been done for *Ptinus tectus*, *Laemophloeus*, and for the *Tyroglyphid* mites, while a classical piece of work was undertaken on our behalf by Richards and Waloff, of the Imperial College of Science and Technology, on the moth *Ephestia elutella*.

While there is no intention of discontinuing this type of investigation, we are tending to modify the form of experimentation in such a way as to provide data for the study of insect numbers and population growth.

In practice we have to deal with the peaks of population fluctuations. In most places in which foodstuffs are stored one can find a certain number of insects. Although, ideally, such stores and factories should be entirely free from any infestation, this is only possible in the most highly civilised countries. In reality these insects are most important when they reach epidemic proportions, and the existence of small endemic populations is chiefly significant in so far as these small populations may, under certain favourable conditions, rapidly develop into what have so well been called "unbridled infestations". It is with the causes of these rapid population growths that we must concern ourselves.

Another interesting population problem arises when one attempts to control insects by steadily reducing their numbers over a long period. I have in mind the use of, say, DDT as a semi-permanent residual spray or as an impregnating agent for sacks.

Can such methods ever completely eliminate an infestation, or, if not, can they reduce it to a level too low for the development of major outbreaks? These are questions to which we do not know the answers, but which are important, from a theoretical as well as from a practical point of view.

It is our purpose to study not only single factors but such factors operating in combination; and to observe the effect of such combinations not only upon single individuals but upon populations. Such factors may be physical, e.g., temperature, humidity or the presence of excess foodstuff, or they may be biotic, as when bacterial disease decimates the migrating larvae of *Ephestia* or when, in summer, the predatory mite *Cheyletus* destroys whole populations of *Tyroglyphus*. In other words, our aim is to study the epidemiology of stored product pests.

2. Closely linked with this work, but of sufficient importance to deserve special mention, is the investigation of the relationship between insects and fungi. I am quite sure that there is much of importance to be discovered here. There are, of course, certain outstanding examples of such inter-relationship. The infestation of bulk grain by *Calandra* or other insects can, and frequently does, cause heating. The heat generated by the activity of the insects is not sufficient, of itself, to cause serious damage to the grain, for the temperatures attained hardly exceed the thermal death point of the insects, e.g., about 40° C, and most grain can safely withstand such conditions. The real damage is done by fungi, whose growth is stimulated by the condensation of water vapour rising through the grain from the heated insect-ridden layers.

Again, the infestation of copra by the Clerid beetle *Necrobia rufipes* is often associated with heavy mould growth, though in this case we do not know whether the insect attack initiates or follows the development of fungi.

Many other products are liable to serious damage from insects and from moulds. It is important that each should be studied, but even more essential that any interdependence of one on the other should be worked out.

3. In our work on insecticides, which is the subject of a special paper by my colleague Dr. Parkin, we have had to cover a fairly wide field and the whole of our energies have had to be directed to the solving of practical problems. We may claim, I think, that the work has been attended by a certain measure of success, but here, again, we have until recently had no opportunity for doing any basic work. I may perhaps put it very simply in another way. We have been finding out whether certain things will kill insects, and under what conditions. We have not had the opportunity to try to find out how they kill.

The development of testing methods and of statistical standards of assay calls for scientific work of a very high order, but once these precision tools have been manufactured, their operation becomes a matter of skilful routine and can be undertaken by less qualified staff under suitable supervision. I am not suggesting that it is any the less important for that; it is needed as long as there are new practical problems to be solved and new insecticides to test, but underlying this strictly applied work there must be a live body of fundamental research.

This fundamental research on insecticides may take different forms. One of the staff is occupying himself with mathematical considerations concerning, among other things, the extent to which insecticides may exert a joint or independent action, when used together.

Another, working with the fumigant methyl bromide, has discovered the inhibition of certain enzymes by this gas. This work, which was begun as an investigation of the reaction of methyl bromide with foodstuffs is likely to throw important light on the toxicological action of methyl bromide to man.

A study is also being made in the Laboratory of the causes underlying the variation in insect resistance to insecticides. We have found that, however much we standardize our breeding and handling processes—and we have gone to extreme lengths—there still remains within a single insect species a residual variation in resistance sufficiently great as to slow up quite seriously our rate of experimentation. Such variation may be due to a single factor or to a combination of factors. It may be genetical in origin, or physiological or even morphological. I feel confident that whatever the causes, their discovery will advance our knowledge of insecticidal action very materially.

Finally, I should like to mention a new line of work upon which we have recently embarked.

As I have indicated, a considerable proportion of our work on fumigants is the study of the sorption and interaction of the gas on the foodstuff being treated.

With chemical methods one can do much, but their sensitivity is limited and the analysis of very small samples is sometimes impossible. The use of radioactive tracer elements provides a tool with which one can attack problems hitherto considered impregnable.

It is however the possible application of this technique to insect toxicology that I wish particularly to mention.

There is no insuperable difficulty in the preparation of fumigants and other insecticides with one or other of their elements rendered radio-active.

Using such "labelled" elements, we propose to investigate the penetration of insecticides through the insect cuticle, the tissues in which they are taken up and the way in which they are eliminated from the insect body. It would be unwise to say more of this at present, as we are only at the threshold of the work, but I am hopeful that we may be able, through the use of these radio-active insecticides, to make some contribution to our existing knowledge of insect toxicology.

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## UEBER EINIGE VORRATSSCHÄDLINGE IN SCHWEDEN

Von Rolf Mathlein

Einleitend möchte ich darauf hinweisen, dass wir in Schweden verhältnismässig wenige Arten von Vorratsschädlingen haben, die von grösserer Bedeutung sind. Das hängt natürlich mit unserem ziemlich strengen Klima zusammen. Sehr oft sind importierte Ladungen von Getreide, Futtermitteln, Kolonialwaren u. s. w. stark mit Schädlingen infiziert, aber nicht viele dieser Insekten überdauern eine längere Zeit in unserem Lande. Einige dieser unerwünschten Einwanderer haben sich inzwischen auch hier stark verbreitet, und ausserdem haben wir einheimische Schädlinge, die grosse Verluste verursachen.

Zuerst etwas über Getreideschädlinge. Nebenbei bemerkt, hat die Getreidelagerung in den ländlichen Speichern während der letzten zwanzig Jahre in Schweden immer mehr an Umfang abgenommen. Es sind eine grosse Reihe von grossen Lagerhäusern von landwirtschaftlichen Genossenschaften gebaut worden, deren gesamte Kapazität sich 50 % der jährlichen Brotgetreide-Ernte nähert. Dazu kommen die Lagerhäuser, die den grossen Mühlen und Getreidehändlern gehören. Diese Lagerhäuser sind in der Regel mit umfassender Maschinerie für Lüftung, Reinigung und künstlichem Dörren von Getreide ausgestattet. Die Landwirte haben also in grossem Umfang die Möglichkeit, ihr Brotgetreide unmittelbar nach der Ernte zu liefern, und selbstredend sind in den Lagerhäusern die Möglichkeiten, Schadeinsekten zurückzuhalten, grösser als in den bäuerlichen Speichern. Immer noch werden jedoch ansehnliche Mengen von Getreide auch bei den Landwirten gelagert, und zwar Brotgetreide sowohl als auch Futtergetreide.

Es sind hauptsächlich zwei Insektenarten, die hier eine grössere Rolle als Getreideschädlinge spielen. Der allgemeinste und wichtigste Schädling ist die Kornmotte, die hier in Schweden eine eben so grosse Rolle spielen dürfte wie der Kornkäfer in unseren südlichen Nachbarländern. Die Kornmotte ist hier als einheimisch zu betrachten. Schon Anfang des achtzehnten Jahrhunderts erwähnt man sie als einen schlimmen Schädling zum Beispiel in den grossen staatlichen Speichern, in denen Getreidereserven zwecks Verhütung von Hungersnot in Zeiten von Missernten und Krieg lagerten. Die in Schweden wenigstens heutzutage vorkommende Kornmotte ist mit der von Dr. Friedrich Zacher 1938 beschriebenen *Tinea secalella*, oder *Tinea infimella* H.S., wie sie neuerdings heissen soll, identisch. Alle Kornmotten-Proben, die ich in verschiedenen Gegenden Schwedens eingesammelt habe, sind ausnahmslos *Tinea infimella*. Die Kornmotte greift Getreide aller Art an, vorzugsweise doch Roggen, ausserdem Hülsenfrüchte, wobei besonders Erbsen schwer beschädigt werden, ferner Mais, Lein- und andere Samen und Kraftfuttermittel verschiedener Art. Die Raupen sind somit gar nicht wählerisch hinsichtlich der Nahrung. Es ist daher ganz überraschend zu lesen, dass *Tinea infimella* in England nur an Pilzen, vermutlich Baumschwämmen, gefunden worden ist. Die Kornmotte kommt in allen denjenigen Teilen Schwedens, wo Getreide gelagert wird, vor, ist jedoch besonders verbreitet in den westlichen Teilen, d. h. den Provinzen, die den Wennersee umgeben. Dass zwei Generationen im Jahr vorkommen, ist sehr gewöhnlich, z. B. besuchte ich diesen Sommer am 10. Juli einen Speicher und fand in einer Roggenpartie zahlreiche Puppen und auch frischgeschlüpfte Motten.

In den DDT- und Hächchlor-Präparaten haben wir nunmehr ausserordentlich wirksame Bekämpfungsmittel gegen die Kornmotte. Folgende Anwendungsmethode hat sich besonders gut bewährt: im Frühjahr, schon bevor die Motten zu schlüpfen beginnen, bespritzt man die infizierten Speicher mit einer Öl-Lösung von DDT (und Hächchlor) in wässriger Emulsion. Die Bespritzung wird nach einem Monat wiederholt. Gleichzeitig werden die Getreidehaufen mit denselben Insektiziden als Stäubemittel oberflächlich behandelt. Mit diesem Verfahren kann man die Eilegung der Motten praktisch genommen vollständig vereiteln. Während der letzten Jahre habe ich eine auffallende Verminderung in der Anzahl von Meldungen und Anfragen bei der staatlichen Pflanzenschutzanstalt hinsichtlich der Kornmotte feststellen können. Diese erfreuliche Tatsache hat man ohne Zweifel den neuen hochwirksamen Bekämpfungsmitteln zu verdanken, die uns nunmehr zur Verfügung stehen. Vielen Landwirten hat die Kornmotte früher alles Brotgetreide, das während des Sommers lagerte, schwer beschädigt, in manchen Fällen hat der Schädling Getreidelagerung während des Sommers überhaupt unmöglich gemacht. Jährliche Verluste von vielen tausend Kronen für einzelne Landgüter sind keine Seltenheiten gewesen.

Im Vergleich mit der Kornmotte spielt hier in Schweden der Kornkäfer, *Calandra granaria*, als Getreideschädling eine untergeordnete Rolle. Das hängt unter anderem von der mehr begrenzten geographischen Verbreitung des Kornkäfers ab. Er kommt, was bäuerliche Speicher betrifft, nur in den südlichsten Teilen des Landes vor, das heisst Schonen mit den angrenzenden Küstenprovinzen. Dort ist er jedoch ziemlich verbreitet und in manchen Fällen ein schlimmer Schädling. Mit Getreide aus jenen Gegenden wird der Käfer in Brauereien, Mühlen u. s. w. manchmal in nördlichere Teile des Landes eingeschleppt, kann sich aber dort nicht längere Zeit halten. Auf diese Verbreitungsfrage möchte ich etwas näher eingehen.

Als Ausgangspunkt wähle ich einen Aufsatz von F. S. Bodenheimer: „Ueber die ökologischen Grenzen der Verbreitung von *Calandra oryzae* L. und *Calandra granaria* L.“ in der Zeitschrift für wissenschaftliche Insektenbiologie 1927. Er baut auf den von Back und Cotton 1924 publizierten Untersuchungen über die Kältefestigkeit der Korn- und Reiskäfer auf. Beiläufig bemerkt, habe ich bei fortgesetzten genauen Untersuchungen gefunden, dass die Widerstandskraft gegen niedrige Temperaturen bei dem Kornkäfer nicht so unbedeutend grösser ist, als ich in meiner Arbeit über die Getreidekäfer 1938 (Statens växtskyddsanstalt, Meddelande nr 23, Stockholm) angab, und auch grösser als die von Back und Cotton bearbeiteten Daten. So ist zum Beispiel die maximale Lebensdauer der Käfer bei  $0^{\circ}\text{C}$  nicht 73 Tage, sondern kann 85 Tage übersteigen. In Getreide mit einer konstanten Temperatur von  $-2^{\circ}$  können die Käfer bis zu 50 Tagen, die Brut innerhalb der Körner bis zu 30 Tagen leben, also nicht nur 40 bzw. 14 Tage, wie früher angegeben wurde. Dies also nur nebenbei gesagt. Als untere Verbreitungsgrenze für den Kornkäfer gibt Bodenheimer ein Monatsmittel der Temperatur von  $-5^{\circ}\text{C}$  an. In Schweden kommt aber solch ein niedriges Monatsmittel nur in Norrland und Dalarna vor, während, wie oben ausgeführt, der Kornkäfer dauerhaft nur in den allersüdlichsten Provinzen vorkommt. In nördlichen Gegenden kommt der Kornkäfer nirgends in den bäuerlichen Speichern vor; die meisten Landwirte dürften den Schädling überhaupt niemals gesehen haben. Für Schweden möchte ich als untere Verbreitungsgrenze des Kornkäfers eine Mitteltemperatur während drei aufeinander folgender Monate von  $\pm 1^{\circ}\text{C}$  angeben. Meiner Ansicht nach hängt doch das Vorkommen des Kornkäfers in Süd-Schweden nicht vorwiegend mit dem milderen Klima, sondern wenigstens in eben so grossem Masse mit den Lagerungs-

bedingungen für das Getreide zusammen. In ganz Mittel-Schweden und weit nach Süd-Schweden hinab lagern die meisten Landwirte ihr Getreide in völlig freistehenden, für diesen zweck speziell aufgeführten Speichern. Im südlichsten Schweden dagegen wird das Getreide in sehr grossem Umfang auf Böden gelagert, die über oder neben Tierställen oder Wohnungen belegen sind. Das ist besonders bei den Bauernhöfen die Regel. Teils werden dadurch die Lagerräume klein, wodurch das Getreide oft in allzu dicken Schichten gelagert werden muss, teils ist es nicht möglich, stärkere Abkühlung des Getreides im Winter zu erreichen. In unserem Nachbarland Dänemark sind die Lagerungsbedingungen für das Getreide den südschwedischen ähnlich, und dort ist der Kornkäfer ein ernsthaftes Problem.

In den „Nachrichten für den deutschen Pflanzenschutzdienst“, 1940, sind Untersuchungen von H. A. Kirschner und G. Kunike über den Einfluss der Winterkälte auf den Kornkäfer publiziert. Aus diesen scheint hervorzugehen, dass auch in Deutschland die Ueberwinterung des Kornkäfers in hohem Grade damit zusammenhängt, dass so viele Getreidespeicher wegen der Plazierung in geheizten Gebäuden die Ausnutzung der Winterkälte zu Abkühlung des Getreides nicht ermöglichen. Kunike erwähnt indessen auch, dass in Grossgetreidelagern mit grösserer Schütthöhe eine für die Abtötung von Kornkäfern ausreichende Abkühlung nicht erreicht werden kann. Hier in Schweden mit unserem längeren Winter gibt es im allgemeinen keine grösseren Schwierigkeiten, auch mächtige Getreidelager genügend abzukühlen. U. a. pflegt man in grossem Umfang verschiedene Dörrapparate während stärkerer Kälteperioden als Abkühlungsmaschine für das Getreide zu benutzen.

In den DDT- und Hächlor-Präparaten haben wir nunmehr wirksame Bekämpfungsmittel auch gegen den Kornkäfer. U. a. kann man durch Beimischung sehr kleiner Pulvermengen die Käfer in verseuchtem Getreide schnell abtöten und das Getreide vor neuem Befall für unbegrenzte Zeit schützen.

Unter den Schadeinsekten an Getreideprodukten wie Mehl, Griess, Brot u. s. w. sind die Mehlmotte, *Ephestia Kühniella*, und der Brotkäfer, *Stegobium paniceum*, sehr allgemein. Die Mehlmotte wurde zum erstenmal in Schweden 1894 beobachtet; es war in einer Mühle in Stockholm, und der Schädling dürfte mit nordamerikanischem Weizen eingeschleppt worden sein. Er verbreitete sich zu Beginn dieses Jahrhunderts sehr schnell, und jetzt dürfte keine einzige Mühle in Schweden von diesem Insekt völlig frei sein. Die Motte ist ein gefürchteter Schädling auch in Hartbrot- und Schokoladenfabriken. Die Kosten der Lebensmittelfabriken für Bekämpfung der Mehlmotte, wobei hauptsächlich Zyanwasserstoff verwendet wird, dürften jährlich in Schweden ein paar hundert tausend Kronen ausmachen. Auch in den grossen Lebensmittellagern des Heeres ist die Mehlmotte manchmal sehr lästig. Dort ist jedoch der Brotkäfer vielleicht noch gefürchteter, der in manchen Fällen sehr schwere Schäden anrichtet, z. B. an Makkaroni und vor allem an Hartbrot, das ja eine schwedische Spezialität ist, und das von der Heeresverwaltung in sehr grossen Mengen oft viele Jahre lang gelagert wird.

Der Brotkäfer kann auch in Mittel-Schweden in unerwärmten Speichern überwintern. Ausgeführte Versuche zeigen, dass die Larven mehr als einen Monat eine konstante Temperatur von  $-6^{\circ}\text{C}$  überleben können. Der Entwicklungsnullpunkt scheint auch ziemlich niedrig zu liegen. In einem Versuch verwahrte ich mit Ei belegtes Brot bei einer durchschnittlichen Temperatur von etwa  $+11^{\circ}\text{C}$ , mit kurz-zeitigen Schwankungen zwischen  $+7\frac{1}{2}$  und  $+14\frac{1}{2}^{\circ}$ , und nach wenig mehr als 6 Monaten gab es

in dem Brot erwachsene Larven. Nach insgesamt 9 Monaten begannen vereinzelte Käfer zu schlüpfen.

Betreffs der Bekämpfung des Brotkäfers in Grosslagern deuten die Erfahrungen darauf hin, dass durch Ueberspritzen oder Ueberstäuben der Lager mit DDT-Präparaten die Weiterverbreitung des Schädlings innerhalb des Lagers erfolgreich verhindert werden kann.

Zum Schluss einige Worte über den dunklen Reismehlkäfer, *Tribolium destructor* Uytt., einen Schädling, der während der letzten zehn Jahre sehr allgemein in Schweden geworden ist. Besonders während der Kriegsjahre verursachte uns dieses Insekt viel Kummer, da täglich viele Meldungen über mehr oder weniger grosse Schäden an Lebensmittelvorräten einliefen. Von der Staatlichen Pflanzenschutzanstalt wurde eine intensive Propaganda, mit Ausnutzung u. a. des staatlichen Rundfunks, für Bekämpfung dieses Schädlings durchgeführt. Beträchtliche Mengen von unersetzlichen Lebensmitteln wurden durch ihn geschädigt oder völlig zerstört. Die Mehrzahl der Menschen hier in Schweden scheint ausserdem unter einem schweren Insektenschreck zu leiden, mit der Folge, dass man oft Lebensmittelverpackungen kassiert, die auch nur einen unbedeutenden Angriff von Insekten aufweisen. Besonders ist der dunkle Reismehlkäfer wegen des unangenehmen Geruchs, den die Käfer von sich geben, gefürchtet. Betr. der Stinkdrüsen des Käfers liegt übrigens eine interessante Untersuchung vor, die von Dr. N. B. Palm vorgenommen und in „Opuscula Entomologica“ (herausgegeben von Societas Entomologica Lundensis), 1946, Heft 3—4, veröffentlicht ist. Das Sekret enthält u. a. freie Kresole, also ein starkes Insektengift.

Als Bekämpfungsmittel gegen *Tribolium destructor* und verwandte Arten von Mehlkäfern haben sich die sogenannten Octachlor-Präparate ( $C_{10}H_6Cl_8$ ) sehr gut bewährt, sowohl betr. schnell lähmender und tötender Wirkung als auch betr. Dauerschutzwirkung. Gegen diese Schädlinge ist Octachlor viel wirksamer als DDT.

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## CONTROL OF STORED PRODUCT INSECTS WITH CONTACT INSECTICIDES

By E. A. Parkin

The immediate problem facing the Pest Infestation Laboratory in England, when it was started in 1940, was the control of insects attacking stored foodstuffs, especially grain and grain products. Before the war of 1939—45 only a relatively small proportion of the grain handled in Great Britain each year was kept in store for more than a few months and most of this was in buildings made for the purpose. Warehouse hygiene was normally sufficient to keep infestation at a low level. During the war stocks were greatly increased and much grain had to be held in makeshift stores quite unsuitable for the purpose and usually not able to be sealed for fumigation. This meant that much reliance had to be placed on contact insecticides, and I wish to describe to you some of the work done on these materials at the Pest Infestation Laboratory.

When the war started the only contact insecticide in regular use in warehouses in Great Britain was a solution of pyrethrins in a non-volatile base oil (to avoid fire risk) for control of the moths *Ephestia elutella* and *Plodia interpunctella* infesting dried fruits. When infestation of grain by such insects as *Calandra granaria*, *C. oryzae*, *Ephestia elutella*, *Ptinus tectus*, *Tribolium castaneum*, *T. confusum*, *Laemophloeus* spp., *Oryzaephilus surinamensis* etc., began to reach alarming proportions, it was decided as an emergency measure to recommend the spraying of building surfaces with films of 1.6 % w/v. pyrethrins in a heavy oil.

This recommendation had been made only a short time when we were faced with the world shortage of pyrethrins and had to develop biological methods for evaluating possible substitutes (1,7). No material tried as an oil spray was so efficient as the pyrethrins, and research was directed towards improvements in practical spraying to utilize the available pyrethrins most economically. We improved some of the spraying equipment then available and showed that adult *Calandra granaria* could be killed by a direct spray of the base oil alone, this species being particularly sensitive to oils (2). But most effort was put into an investigation of the persistence of films of oily insecticides sprayed on to different building materials. We discovered that it was practically impossible to form persistent toxic films on materials like limewashed bricks, concrete, and cement, which were highly absorptive. A method of pretreatment was devised whereby such surfaces were treated with an oil-impermeable material like size or gelatin solution before spraying with the insecticide. With this sort of treatment, an insecticidal film that otherwise loses its toxicity in a few hours can be made to remain highly toxic for a month or more (3, 4, 8).

Whilst this work on oil-based sprays was in progress, an investigation of the possibilities of the large-scale use of so-called inert mineral dusts was being undertaken. Much was learned about the factors governing the insecticidal efficiency of these dusts such as concentration, relative humidity, temperature, particle size, hardness etc., and many materials within the range of those available in wartime were tested for suitability. Experiments also showed that the dusts could be satisfactorily removed from grain during the ordinary mill cleaning processes before grinding to

\*flour. In a trial of three finely ground dusts (felspar, dolomite, and anhydrite) each applied to 50 tons of grain, the cloud of dust in the atmosphere during treatment and subsequent handling was considered to be too dense for reasonable commercial practice (5). Mineral dusts were therefore never used on a large scale in Great Britain but were used as barriers between piles of goods to prevent spread of infestation by insects and, especially, by Tyroglyphid mites.

Early in 1943 we started investigations on DDT and found that, as a spray in heavy oil, it had little value, but was highly toxic when used as a chemical dust mixed with grain. Similar results were obtained with benzene hexachloride (BHC), but this substance has the practical disadvantage of being more irritant to operators. Because dust clouds would probably be formed during handling, however, neither of these chemical dusts is likely to be mixed with grain in Great Britain, except perhaps for the protection of seed stocks on farms; but considerable attention is being paid to the use of DDT and BHC in this form in some of the colonies. We have shown that much of the DDT dust is removed from grain by the ordinary mill cleaning processes but a final persistent residue of 10 or more parts per million may remain. We are now investigating the amount of DDT that may be taken up by grain, after the two have come into contact in different ways.

DDT and BHC have been used successfully as barrier dusts. BHC has the advantages of quicker action and much greater toxicity to mites, but the disadvantage of unpleasant smell.

The impregnation of sacking with DDT has been another line of investigation. The degree of protection against infestation is related to the closeness of the weave of the sacking and the amount of DDT applied. A deposit of 1 % by weight of DDT on the material should give adequate protection to sacked goods in stores which are not heavily infested; and 5 % of DDT should give a high degree of protection at all times, particularly if the material is of sufficiently close weave to afford some mechanical hindrance to penetration by insects (6). An investigation of the transfer of DDT from impregnated sacking to various foodstuffs has shown that the outermost 2.5 cm. of grain or cocoa beans in contact with the sacking will absorb only a few parts of DDT per million. On the other hand, a similar layer of wheat flour, soya flour, or ground nuts without shells, will absorb surprisingly large amounts of DDT, up to several hundred parts per million as shown in Table I: —

TABLE I

	1 %	5 mg./kg.
Wheat	1 %	14 "
	5 %	88 "
Flour	1 %	250 "
	5 %	204 "
Soya flour	1 %	631 "
	5 %	72 "
Groundnuts	1 %	111 "
	5 %	9 "
Cocoa beans	1 %	30 "
	5 %	

These figures were obtained after storage of the foodstuff in the treated sacking for four months; the residues after 13 months of storage were somewhat higher. Such

large scale movement of DDT into a foodstuff emphasizes the great need for care in consideration of toxicological risks before recommending the widespread use of DDT where it may come into contact with foodstuffs, especially if these are fatty and finely divided.

DDT and BHC smokes are now being used in empty stores and for boxed and bagged foodstuffs. They have proved easy and economical to use because careful sealing of a building as for fumigation is not necessary, but they lack power of penetration. In particular they do not penetrate well through dust and debris, and it is most important therefore that smoke treatment should be preceded by thorough cleaning, preferably with a vacuum cleaner. Experiments have shown that about 25 mg. of insecticide will penetrate 1 sq.m. of ordinary grain sacking, but it must be remembered that insecticide deposited on the sacking may slowly diffuse into the foodstuff during storage. A particularly high risk of contamination occurs when flour, oatmeal, etc., are recovered during the cleaning of "empty" sacks and used for human or animal consumption.

Although we are investigating the ways in which we can use the new synthetic compounds in Great Britain for the control of stored product insects, I am sure that pyrethrum extract will not be displaced from favour for a long time, because of its toxicological safety and its fast paralytic action. More work is required, however, on the problems of increasing the lethal effect of the pyrethrins and of increasing their stability to oxidation by mixing them with suitable substances of low toxicity to man and therefore applicable directly to foodstuffs. The relatively recent development and marketing in U.S.A. of mixtures of pyrethrins and piperonyl butoxide or piperonyl cyclonene indicate that worthwhile progress can be made in this direction.

It may happen that some day a single insecticide will be discovered which will be highly toxic to all insects and mites infesting stored products, persistent over long periods of time, yet not dangerous to man nor liable to taint the product. Until that discovery is made, we research workers of all countries must continue to increase the list of insecticidal compounds which are suitable for use in food stores, and to learn by scientific experiment their advantages and disadvantages.

With this knowledge we can make expert selection from the list of an insecticide or a combination of insecticides in the physical state of solution, emulsion, dispersible powder, dust, smoke, etc., most suited to the particular problem of infestation to be solved. One day, perhaps, we shall have completed all the investigations we have in mind and will then be able to concentrate on the proper practical use of the knowledge we have gained; but this day steadily becomes more distant, for new insecticides are being discovered and developed faster than they can be adequately tested.

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## OBERFLÄCHENAKTIVE PULVER UND KONTAKTINSEKTIZIDE

Von Friedrich Zacher

Der Kornkäfer, *Calandra granaria* L., hat seit jeher in Deutschland eine sehr grosse wirtschaftliche Bedeutung und seine Bekämpfung ist besonders in Bauernspeichern wegen der dort herrschenden Verhältnisse sehr erschwert. Deshalb habe ich auf die Entwicklung ungiftiger Stäubemittel grossen Wert gelegt und bin dabei zu der Entdeckung der wasserentziehenden Wirkung oberflächenaktiver Pulver gekommen. Über die Ergebnisse meiner Untersuchungen habe ich 1935 und 1938 auf den Internationalen Entomologen-Kongressen in Madrid und Berlin berichtet. Damals waren meine Arbeiten nach meiner zwangsweisen Pensionierung durch die nationalsozialistische Regierung sehr behindert. Seit dem sind auch in anderen Ländern zahlreiche Untersuchungen über das gleiche Problem ausgeführt worden, und es war mir eine besondere Freude, mich hier mit den Kollegen darüber aussprechen zu können. Meine Theorie, dass die oberflächenaktiven Pulver den Tod der Insekten durch Wasserentzug herbeiführen, ist von vielen Seiten bestätigt worden, dagegen ist für den ursächlichen Grund dieses Wasserentzuges noch keine vollkommen befriedigende Erklärung vorhanden. Von den vielen Deutungsversuchen sind vor allem die Ansichten von Wigglesworth und Parkin beachtenswert. Wigglesworth ist der Meinung, dass zunächst durch spitze oder scharfkantige Mineralteile mechanische Läsionen der Epicuticula entstehen und dass dann die Ausfüllung der Lücken durch Adsorptionswirkung verhindert wird. Deshalb soll nach seiner Ansicht der Effekt bei toten oder betäubten, bewegungslosen Tieren nicht eintreten. Nach den Beobachtungen, die ich machte, scheint diese Theorie aber nicht zu stimmen. Sowohl bei den mit  $\text{CO}_2$  betäubten Kornkäfern, wie mit  $\text{CS}_2$  getöteten Tieren führt die Bestäubung mit  $\text{SiO}_2$ -Pulver zu einer Steigerung des Wasserverlustes, wie die folgende Tabelle zeigt:

Betäubte Tiere $\text{CO}_2$ + Kieselgel		( $\text{CO}_2$ ) Kieselgel	$\text{CO}_2$		Unbehandelt:
tot nach Tagen	4	4	4		11
Gew. Verlust n. 11 Tagen	31,8 %	44,1 %	14,3 %		18,8 %
Getötete Tiere Kieselgel, E		( $\text{CS}_2$ ) Kieselgel, E + $\text{CS}_2$	$\text{CS}_2$		Unbehandelt:
tot nach Tagen	a) 4 b) 4	0 0	0 0		12 13
Gew. Verlust n. 13 Tagen	a) 39,1 % b) 41,7 %	19,7 % 21,6 %	13,8 % 16,8 %		13,6 % 16 %

Wie ich früher bereits mitgeteilt habe, kann das Eintreten des Effektes auch an unbelebten Objekten durch einen Modellversuch nachgewiesen werden. Raupenhäute, die mit physiologischer Kochsalzlösung gefüllt sind, verlieren bei Einbettung in Quarz-

mehl oder Magnesium-Oxyd mehr Wasser, als beim freien Aufhängen in Luft. Die Messung erfolgte durch eine gradierte, mit Wasser gefüllte Kapillare, an welche die Raupenhäute angebunden waren. Dabei ergab sich, dass der Wasserspiegel in einer Stunde bei Einbettung der Raupenhaut in Naaki (Quarzmehl) um 0,23, bei Einbettung in MgO um 0,19, in Luft um 0,12 bzw. 0,14 Striche gesenkt wurde. Ebenso ergab sich, dass Quarzmehl im wasserdampfgesättigten Raum erst in 18 Tagen annähernd die gleiche Menge Wasser (0,12 g) aufnahm, wie von einem mit Wasser getränkten, unglasierten Tonteller innerhalb von 1 Tag (0,13 g). Damit ist bewiesen, dass die oberflächenaktiven Pulver bei Kontakt das Wasser mit grosser Kraft an sich reissen. Man kann also in der wasserentziehenden Wirkung der oberflächenaktiven Pulver 2 Komponenten unterscheiden. Von diesen ist die eine physikalisch-chemisch bedingt und führt bei toten Käfern zu einem Wasserverlust von 19,7 bis 21,8 %; die andere ist biologisch-physiologisch bedingt und steigert die Gewichtsabnahme bei lebenden, nicht betäubten Kornkäfern bis zu 44 %, dagegen bei lebenden, aber betäubten Tieren auf 31,8 %. Trotzdem reicht aber die Wasseradsorption zur ursächlichen Erklärung des Effektes nicht aus. Die Untersuchung der Wasseradsorption mit dem Enslinschen Apparat ergab keine Parallele der Absterbezeit des Kornkäfers weder mit der maximalen Wasseraufnahme, noch mit der maximalen Geschwindigkeit der Wasseraufnahme. Alle diese Versuche scheinen mir zu zeigen, dass die Theorie von Wigglesworth keine ausreichende Erklärung für die Erscheinungen bietet. Ausserdem habe ich schon früher nachgewiesen, dass der Effekt nicht nur durch scharfkantige Splitter von Steinen hervorgerufen wird, sondern z. B. auch durch Kieselkreide mit abgerundeten Teilchen und durch feinflockige Stoffe, wie Magnesium-Oxyd (*Magnesia usta levis*) oder Aktivkohlen, die kaum geeignet sind, mechanische Läsionen zu verursachen. Jedoch hat Wigglesworth, wie schon gesagt, insofern recht, als der Effekt nicht rein biologisch-physiologisch bedingt ist, sondern auch eine chemisch-physikalische Komponente enthält. Meine Versuche ergaben die beste Übereinstimmung mit den Anschauungen, die von Parkin 1944 geäussert worden sind, nämlich, dass die entscheidende Rolle einer Adsorption von Lipoiden zukommen muss. Es wäre von vornherein auch schwer erklärbar, wie das Wasser durch die Haut der Insekten entfernt werden sollte, ohne dass die hydrophoben Lipide beeinflusst werden, die hauptsächlich in der Epicuticula der Insekten den Verdunstungsschutz bilden. Es ist jedoch fraglich, ob es sich hierbei nur um eine Adsorptionserscheinung handelt. Ich möchte eher annehmen, dass ausserdem eine Beeinflussung des kolloidalen Zustandes der Schutz-Lipide erfolgt. (Besonders auch bei den Aktivkohlen). Zur Erklärung möchte ich folgende erläutern:

Wenn man sich eine Emulsion von Öl und Wasser vorstellt, so kann entweder der eine oder andere Bestandteil disperse Phase oder Dispersionsmittel sein. Je nachdem wird auch das System entweder hydrophil oder hydrophob sein. Eine derartige Verschiebung könnte ich mir als eine Erklärung des „Zacher-Effektes“ vorstellen. Die Anwendung der oberflächenaktiven Pulver ist deshalb wichtig, weil sie ohne sich selbst zu verändern, dem Getreide einen dauernden Schutz gegen Befall bieten können. Im Zusammenhang damit war die Frage aufgeworfen worden, ob mit Aktivpulvern bestäubtes Getreide auf die Kornkäfer abschreckend wirkt. Zu dieser Frage habe ich einige Versuche ausgeführt und dabei gefunden, dass im nicht verdunkelten Raum sich von den Kornkäfern 83 % in das nicht behandelte, aber nur 10 % in das mit Quarzmehl behandelte Getreide begeben hatten. Im verdunkelten Raum waren 79,2 bis 89 % in unbestäubtem Getreide, dagegen nur 10,2 bis 19 % in bestäubtem Getreide vorhanden. Es ist also klar ersichtlich, dass die Einstäubung des Getreides die Mehrzahl

der Kornkäfer von der Einwanderung in das Getreide abschreckt. Dagegen hat eine bloss e Einstäubung des Bodens die Einwanderung der Käfer in unbehandeltes Getreide nicht verhindert.

T a b e l l e 2

*Abschreckende Wirkung der Einstäubung von Getreidehaufen mit  $\text{Si O}_2$  auf Kornkäfer.*

Anzahl der Käfer:	1. Im Licht (420 Käfer): Eingestäubte Haufen:	Zwischen den Haufen:	Nicht eingestäubte Haufen:
	31 = 10 %	20 = 6,6 %	249 = 83 %
Anzahl der Käfer:	2. Im Dunklen (400 Käfer): Eingestäubte Haufen:	Zwischen den Haufen:	Nicht eingestäubte Haufen:
	95 = 19 %	9 = 1,8 %	396 = 79,2 %
Anzahl der Käfer:	3. Im Dunklen (500 Käfer): Eingestäubte Haufen:	Zwischen den Haufen:	Nicht eingestäubte Haufen:
	51 = 10,2 %	4 = 0,8 %	245 = 89 %
Anzahl der Käfer:	4. Im Licht 2 Getreidehaufen unbestäubt, Fussboden zur Hälfte bestäubt! (500 Käfer):		
	Im Getreide auf bestäubtem Untergrund:	Zwischen den Haufen:	Im Getreide auf unbestäubtem Untergrund:
	218 = 43,6 %	13 = 2,6 %	269 = 53,8 %

Nachdem sich in den letzten Jahren neue Kontaktinsektizide, und unter diesen besonders die DDT-Präparate als vorzügliche Bekämpfungsmittel auch besonders gegen den Kornkäfer bewährt hatten, lag die Überlegung nahe, dass ein Teil dieser Wirkung vielleicht auch auf der oberflächenaktiven Eigenschaft der Trägerstoffe beruhen könnte. Als Trägerstoffe dienen ja zum Teil Gesteinsmehle, (z. B. Schiefermehl), die an sich schon insektizid wirken können. Ich habe zunächst einmal Schiefermehl auf seine oberflächenaktive Wirkung hin untersucht, bin dabei aber zu keiner Klarheit gekommen. Die 100 %ige Abtötung der Kornkäfer erfolgte in manchen Fällen bereits nach 4 Tagen und war mit der Wirkung von Quarzmehl vergleichbar. In anderen Fällen war sie doppelt so lang, oder noch länger als bei Quarzmehl, was auf verschiedener Vermahlung beruhen kann. Immerhin ist aber die insektizide Wirkung vorhanden. Ich hatte nun angenommen, dass dann, wenn man ein oberflächeaktives Gesteinsmehl mit DDT-Wirkstoff kombiniert, die insektizide Wirkung beider Stoffe sich addieren, und die Wirkung entsprechend schneller eintreten müsste, als bei jeder der beiden Komponenten allein. Zu meinem Erstaunen musste ich aber feststellen, dass das durchaus nicht der Fall zu sein braucht. Ich verwendete in einem Vergleichsversuch einmal reines

Schiefermehl und in einem Parallelversuch Schiefermehl + 5 % DDT-Wirkstoff. Die Abtötungszeit in beiden Versuchen war die gleiche, nämlich 10 Tage. Weitere Versuche wurden mit Quarzmehl, Kieselgel, Magnesium-Oxyd, Aluminium-Oxyd und Zuckerkohle vorgenommen und zwar 1.) mit der Substanz allein und 2.) im Parallel-Versuch mit Zusatz von 5 % DDT-Wirkstoff. Bei allen diesen Stoffen, mit Ausnahme von Zuckerkohle, wurde durch den DDT-Wirkstoff keine Beschleunigung der Abtötung erzielt, nur bei Zuckerkohle trat im Versuch mit DDT-Wirkstoff eine Beschleunigung der Wirkung um einen Tag ein, dagegen wirkte Magnesium-Oxyd und Aluminium-Oxyd und Aluminium-Oxyd ohne Wirkstoff um einen Tag schneller, als mit Zusatz von DDT. Es waren das nur einige Tastversuche; sie zeigen aber, dass die Auswahl des Trägerstoffes nicht gleichgültig ist, sondern dass hier offenbar physikalisch-chemische Wechselwirkungen vorliegen, deren Studium eine dankbare Aufgabe sein dürfte. Es wäre zu prüfen, ob nicht vielleicht organische Trägerstoffe den Vorzug verdienen. Eine weitere Untersuchung dieser Fragen kann sowohl für die Verwertung der oberflächenaktiven Pulver, wie auch für die modernen Kontaktinsektizide von Bedeutung sein.

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## SECTION VIII

### A SURVEY OF SO-CALLED REPELLANT INSECTICIDES, THAT HAVE BEEN DEVELOPED DURING THE LAST YEARS TO PROTECT FROM ATTACKS OF DIFFERENT INSECTS AS MOSQUITOES, MIDGES, BITING FLIES, CHIGGERS ETC. DESCRIPTION OF THEIR CHEMISTRY AND SOME OBSERVATIONS MADE IN SWEDEN WITH SUCH PREPARATIONS

By *E. Askelöf*

#### *Insect repellents.*

During the last ten years and especially during the later part of the war many new, mainly synthetic insecticides intended to have a repellent effect, have been developed and tested. They are particularly interesting in regard to their manner of action and their chemical characteristics. These preparations are not only important for men, but are also used to protect our domestic animals, e.g. the cattles, horses a.s.o. To produce effective insect repellents is therefor a common desideratum and a chemical as well as an entomological problem for the solution of which cooperation between both entomologists and chemists is required. I shall here discuss some general points of view and topical questions concerning these preparations even in regard to swedish experiences.

The literature regarding repellent insecticides is not especially extensive, if one overlooks what is written about some rather old compounds of a generally small effectivity. The preparations that have been developed have been intended only for civilian purpose. Not until it became evident that the substances in question were important for the successful continuation of the military operations, particularly in tropical districts where stinging and bloodsucking insects could have a deleterious effect on the fitness of the troupes for active service. They set upon the task to develop new effective synthetic insect repellents. But because of the secrecy imposed on the manufacturers for military reasons the results that were obtained during the war, were not published to a larger extent.

Since ever so long man has tried to protect himself in different ways against all kinds of stinging or in another way irritating insects by repelling them with mechanical or chemical means of natural or synthetic origin. To the mechanical means count all sorts of protective nets, protective hoods and even protective dresses. To the chemical means count all kinds of saps of plants that e.g. the natives in the Tropics have used out of experience perhaps since times immemorial with varying success. Better known are citronellie-oil, cedarwood-oil, eucalyptus oil, oil of anise, camphor and camphor-spirits.

Repellent substances were before the war only moderately used, depending on their unsatisfactory and transitory effect as protective and deterrent means. Already in 1935 they began to search for more effective substitutes. In 1940 the american Granett published the results of some systematical examinations at Rutger's University, New Jersey. With this, one got hold of certain laboratory methods to estimate the repellent effect and what was required of repellent preparations for e.g. personal use. Among

other things, test-methods were prepared in order to ascertain the practical effect of the insect repellents and even the effect of the climatic circumstances. From the moment America was drawn into the war it became obvious that they had not only to fight the human enemy but also such terrible enemies as *Aedes Egypti* and *Anopheles quadrimaculatus*, to mention a few examples. Therefor a research program in this respect was drawn up under governmental supervision, and a lot of firms began to cooperate in order to produce repellent preparations for military needs. The test-program was co-ordinated by the Insect Control Committee of the National Research Council.

#### *Test-methods and test-objects.*

To try out the large number of compounds in question, it was necessary to establish test-methods that were easy to work with in the laboratories. In an especially designed cage the one side of which is provided with a cloth-window with a cuss through which one puts in the naked arm, the time for "the first sting" is determined. One rubs the testarm with the substance that is to be tested and expose it to the attack of a certain number of chrusalis in the cage. A control test is done by putting in a not treated arm. The time between the beginning of the test and the first sting shows the "repelling effect". Accordingly the test can also be adapted to the specific conditions of the tropical and temperate zones. Surely no great exactness is to be expected of this method but it may provide a certain relative "repelling index" anyway, respectively to different combinations and different insects. The observations showed that 120 minutes for *Anopheles quadrimaculatus* and 180 minutes for *Aedes Egypti* until the first sting had to be looked upon as minimum time for the compound in question, to be regarded as having a sufficiently repellent effect for practical use.

A lot of interesting observations have been made by these examinations. Thus one found that the effect of the preparations was extended if they were mixed with certain solvents. By adding benzylalcohole up to 20 %, the repellent index increased two and a half times. One also found that mixtures of different compounds could have an additional effect that surpassed that of the components, while others had an antagonistic effect on each other. It was established at the above mentioned tests that especially organic compounds, containing naphtyle- or diphenyl-nucleus had a large effectivity. After the here outlined laboratory-tests, field-tests were made in different parts of USA and Central-America and on the Pacific islands. By these tests one gradually got however preparations with a rather good repellent effect.

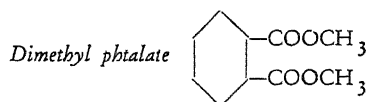
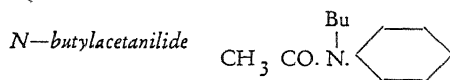
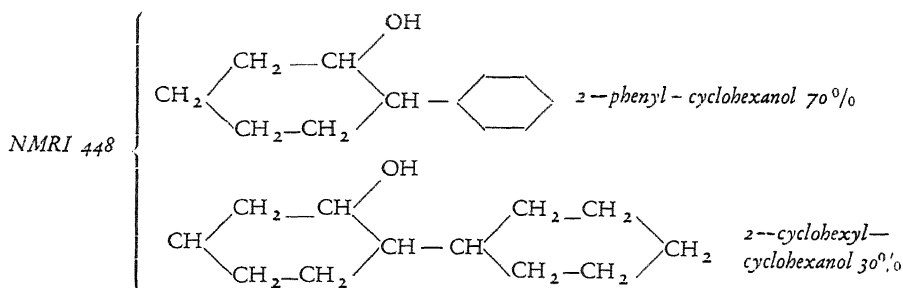
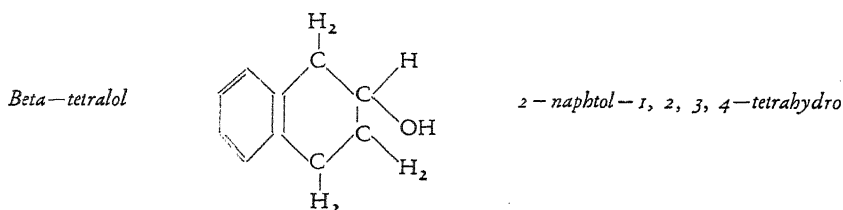
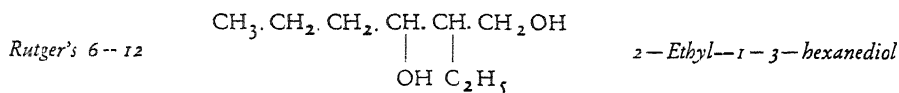
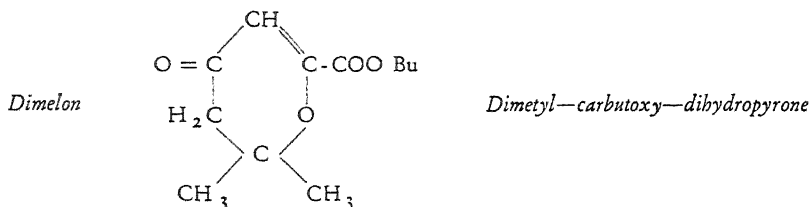
The enormous work that was made by these gathered efforts are proved by the fact that not less than 13,000 compounds and thousands of different mixtures were passed and tested. From these developed a few that proved to be suitable for the intended purposes. It is, however, necessary to remember that the preparations that were developed have been prepared for military use without regard to certain properties such as cosmetical, which for civilian use are desirable or even necessary. The preparations intended for military use could sometimes be irritating to the skin and to the mucous membranes. Further the stability was limited and the ability of dissolving plastics such as nylon and nail-polish etc. was to high. With the increasing interest for such insect repellents for civilian use they were improved even in the above mentioned respects. A good insect repellent ought to have the following characteristics:

- a) a considerable repellent effect on different insects as mosquitoes, gnats, horse-flies, house-flies, biting flies and chiggers.
- b) non-toxic when absorbed through the skin.

- c) none irritating effect on the skin or on the mucous membranes of the eye or the nose and none allergenic effect.
- d) a comparatively agreeable scent.
- e) ability to be compounded into a suitable cosmetical preparation, such as solution, balsam, emulsion, oil or unguent.
- f) no staining effect on cloths or stockings and no dissolving effect on nail-polish.
- g) preferable without colour.

### Chemistry.

Among the rather observed insect repellents that in this way have been developed and been tested against the mentioned parasites, the following are of interest:



As I have already mentioned it is difficult to get an objective absolute or relative estimation from a practical point of view of all these repellent preparations, as their effect varies to the highest degree with different insects and individuals and under different climatic circumstances. Thus it has become evident that in case of certain insects mixtures of the different repellents as well as special textures should be given preference. The practical field-tests made here in Sweden have also shown that the effectivity of the preparations varies very much in sun-shine and when people feel hot. Then the duration of the effectivity may be halved in comparison with the effectivity under opposite circumstances. By tests in the Tropics it has been ascertained that a mixture with the proportions 6: 2: 2 of *dimethyl-phtalate*, *Dimelon* and 6-12 had a synergetic effect, particularly against the dreaded malaria mosquito and by thus a repellent has been developed, named 6: 2: 2.

	Repellent time in minutes. Time to the first stick.	
	<i>Aedes Egypti</i>	<i>Anopheles quadrimaculatus</i>
Dimethylphtalate . . . . .	258	108
612 . . . . .	346	55
Dimelon . . . . .	147	41
6: 2: 2 . . . . .	320	250

During the summer 1947 field-tests were made with about 30 insect repellents by the Canadian Institute of Parasitology. In the course of their tests they found that a combination of 25 % *Dimelon* (*Indalone*) + 75 % *Dimethyl-phtalate* was superiour to *Dimethyl-phtalate* by itself and that they got the best effectivity with the combination 6: 2: 2.

*Ethyl-hexandiol* was evidently a good insect repellent against different kinds of tropical mosquitoes. Rutgers University tested the repellent under different conditions and with different ways of application and found that its repellent effect could be estimated to lay between 2—8 hours, in certain cases even longer. In combination with *Dimethyl-phtalate* the effect of *Ethyl-hexandiol* against the malaria mosquito was fortified. Against the sand-fly they got an effect of a 3—5 hours' duration. It also has the advantage not to have a dissolving effect on plastics, nylon and nail-polish etc.

Pijoan, Naval Medical Research Institute made thorough examinations and at last they found another effective composition of 2-phenyl-cyclohexanol, 2-cyclohexyl-cyclohexanol and ethylalcohol called NMRI 448 that proved to have a repellent effect of 6—10 hours in the temperate zones of USA against *Culex pipiens* and against *Musca domestica*, while the effect against the bluebottle, *calliphora vomitaria* is said to be of a 5—7 hours' duration. These time statements are of course rather approximative and as I have pointed out, this depends on a lot of external elements. "448" too is not dissolving plastics, nylon etc.

Butylacetanilide has proved to give a good repellent effect in combination with phenyl-cyclohexanol against chiggers of different kinds.

Among other preparations which also have been tested, Lethane or butoxytiocyan-diethyl-ether combined with pyretrines in kerosene-base may be mentioned. They are said to have a repellent effect up to 4 days against certain kinds of tropical midges if sprayed in rooms.



### *Observations in Sweden.*

First tests were made in Sweden with special compositions of the mentioned type on cows, calves, horses and even pigs, which could be kept free from insects during a time up to 14 hours, what might be of a practical value e.g. to keep cows free from flies while being milked. The following advantages have been observed

weightincrease of the cow  
higher milk quantities  
better condition.

During the last year, however, this problem has been further studied in Sweden for treatment and prevention of ectoparasitic infections in domestic animals, and certain emulsions to dilute in water containing the insect repellents ethylhexanediol or 448 and DDT and "Hexa" (or hexachlorocyclohexane) and adhering substance have given a protective effect up to 14—28 days in vitro trials. The emulsions had the following strength:

15 0/0—25 0/0 DDT  
5 0/0—10 0/0 "Hexa"  
25 0/0 "6-12" or "448"

Those emulsions were diluted by stirring into water 1:20 or 1:100 to get a concentration of 1.25 0/0—0.1 0/0 of DDT and 0.5 0/0—0.05 0/0 of "Hexa" for use. Trials on horsehair were made with flies and rice-weevil.

The cattle and especially horses could be kept free from bloodsucking insects during the grazing-time by means of 3—4 sprays in summer. That is also a problem for the reindeers (*Oedomagena tarandi*) in the north of Sweden, which are attacked by the reindeer-flies. The preliminary results were promising. Observations of a similar kind have also been made in America.

Both during the summers 1946 and 1947 and during this summer expeditions in the Swedish mountains have tested different insect repellents alone and in combinations on man in the north of Sweden against midges, gnats as well as breezes to get an idea of their effect in the different climatic conditions that are prevailing in Sweden and in districts where these insects are looked upon as especially "blood-thirsty" and "irritating". With regard to the presence of midges and gnats in the Swedish mountains, they have been found up to a height of 1500 metres above sea level. Any difference in the intensity of the swarms has not been observed up to 1200 m. height. Below the tree-limit-line, especially in marshy woodlands the gnats, however, may be much more numerous. Before and after a rain the frequency of insects is increased and at these occasions they are most blood-thirsty too. With an increased force of the wind the midge-frequency decreases and in hard wind and at a low temperature the midges completely disappear.

Hereby it appeared that certain combinations had an additional effect that under similar circumstances surpassed the effect of the individual compounds. On midges and gnats they have an immediately repellent effect, while on breezes (*Hypoderma bovis*) they have effect only by contact. At normal weather and when people can move around without getting warm such combined preparations have proved to have a lasting protective effect during about 5 hours on man, while e.g. ethylhexanediol, NMRI 448, Dimethylphtalate are protective for about three hours under the same conditions. At high temperature and strong physical efforts the protective time decreases considerable by reasons earlier mentioned. Of course also rain has the same effect. Toxic effects have not been observed by these experiments.

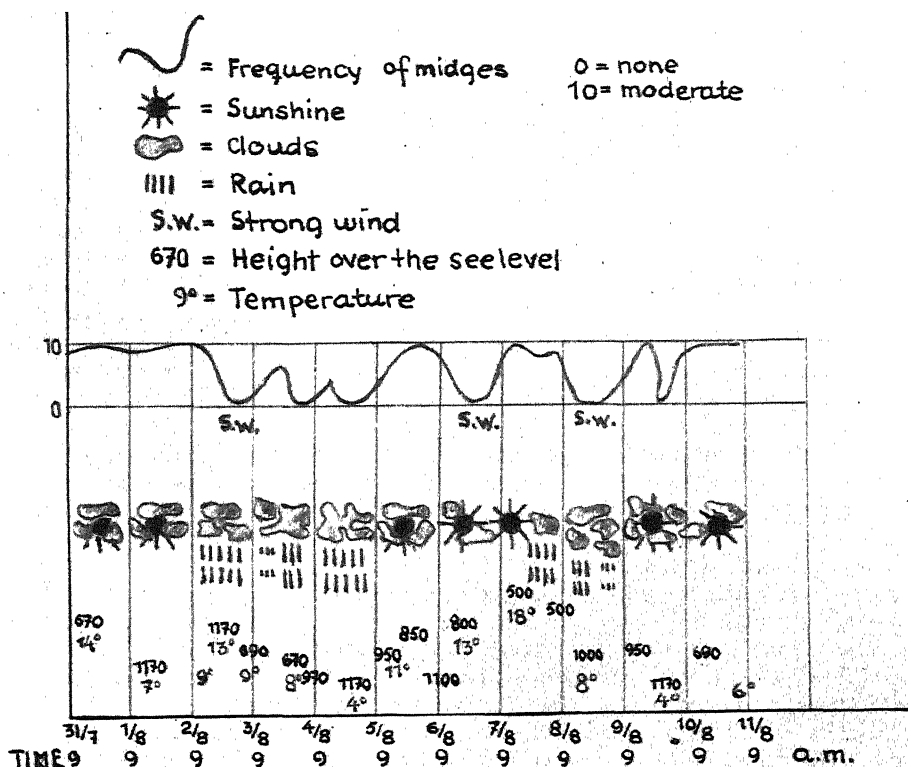
*Application and forms of preparation.*

It is proved by what is said that the repellent effect depends on many external elements and even on the form of preparation of the compounds in question. Most common is to use the repellents if they are liquid, as they are in dilution, but with some indifferent solvent often a longer duration may be obtained by using unguents, jellies suspensions etc. of different types. The best results for man here in Sweden in the mountain have been obtained with the state of emulsion, and for animals a type of emulsions to stir into water. The simplest way to apply the solutions on animals is by spray or by scrubbing.

The here stated new insect repellents seem to have an effect only when the insects come very near the skin and the effectivity of the obtained protection varies from individual to individual, what may be supposed to depend on the perspiration as well as the velocity with which the skin absorbs the repellent in question.

In spite of all the advantages and positive characteristics of these new preparations as deterrent insecticides it cannot be said that we have already obtained the best and most effective one. The examinations in this respect are still going on.

All the above mentioned compounds irritate in a certain degree eyes and mucus membranes and even sometimes the skin, and the effective repellent time varies considerably. An insecticide in a suitable form and lasting for a long time, as well as giving an effective protection without irritating and without scent would be the ideal.



## THE CONTROL OF MALLOPHAGA ON CATTLE BY CONTACT INSECTICIDES

By D. S. Bertram and E. W. Roberts

During investigations on the use of insecticides against the Biting Louse of Cattle (*Damalinea (Bovicola) bovis* L.) it became apparent that visual assessment of the intensity of infestation was inadequate as a criterion for comparative work.

A sampling technique depending upon the response of the lice to heat was developed. A piece of surgical lint placed on the sacral region of an animal is overlaid by an electric pad heated to approximately 30° C by connection to the normal lighting circuit. The pad is left on the animal for 2 minutes, the temperature being checked by inserting a thermometer between the lint and the animal's hide. The pad is then withdrawn, the lint removed, and the number of lice adherent to it taken as a representative sample of the louse population on the animal. Such a sample is referred to as a "lift". "Lifts" have been taken from the sacral region, withers, neck, and belly. The number of lice is counted at once, or the lint is transferred to a labelled envelope and the "lift" counted at leisure.

Observations have been made on cattle treated with "Gammexane" (10 % Dispersible Dust in water) and with DDT (10 % Wettable Powder). The animals were kept under normal winter conditions on a Cheshire farm. About 1½ litres of fluid were required to sponge down each animal completely, sponging being adopted as the method acceptable in British farm practice.

A group of 24 heifers kept indoors except for 1—4 hours daily was used for preliminary investigations. "Lifts" taken from the sacral region on November 27th gave an average of 18 lice per heifer. On December 18th, twelve of the heifers were sponged with 1/10,000 "Gammexane", and twelve with 1/10,000 DDT, the average number of lice per heifer in the two groups before sponging being respectively, 20 and 21. Subsequent samplings on the 5th, 19th, 28th, and 36th days after treatment showed the average number of lice per heifer in the "Gammexane" group to be 0, 11, 31, and 60, and in the DDT group 181, 115, 307, and 233 respectively. The whole herd was then (January 23rd) re-treated with 1/10,000 "Gammexane". Three days later no lice were found on sampling, and on the 7th, 13th, 21st, and 35th days after this second treatment the average numbers of lice per heifer were 1, 5, 6, and 6. It has been observed in the laboratory that a proportion of the eggs on a "Gammexane" treated heifer do not hatch. The majority of the lice occurring in "lifts" shortly after treatment were those which had emerged from surviving eggs but, in addition, a few late stages or adults were found. Adult lice forming over 80 % of the samples taken on the 35th day after treatment represented the first post-treatment generation of adults developed from surviving eggs.

One heifer which yielded 52 lice in a sample taken 36 days after the first "Gammexane" treatment was transferred to a separate building and remained untreated for the rest of the winter. A steady increase of its infestation occurred and 1104 lice were taken from it in a "lift" on February 2nd, the date when an average of 6 lice per heifer was first obtained from the "Gammexane"-treated herd.

Another animal showing 452 lice on sampling was treated with 1/1000 DDT and over a period of eight days the sacral "lifts" dropped to three lice.

These results and those from similar experiments on some 50 animals of the milking herd are still under detailed study and require statistical treatment, but certain general conclusions may be made.

The method of sampling enables the effect of an insecticide to be studied with an accuracy impossible by visual observation. It is apparent that although one treatment of "Gammexane" at 1/10,000 gives a rapid and almost complete kill of lice, the louse population is mainly re-established from a proportion of the eggs which survive the treatment. A new generation of adults is developed by the 5th week after treatment. DDT at 1/10,000 was not only ineffective in controlling infestations but resulted in an apparent rise in the number of lice taken from the sacral region. This is not clearly understood and may be due to some distributional effect following the reaction of the lice to contact with sub-lethal concentrations of DDT. On the other hand, DDT at 1/1,000 gave a slow effective reduction of the infestation over a period of eight days.

In the case of "Gammexane"-treated heifers herded with heavily infested heifers, the degree of contact re-infestation appeared less than might have been expected.

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## INDIKATIONSSTELLUNG UND TERMINFESTSETZUNG ZUR FLUGZEUGSTÄUBUNG IN DER MALARIABEKÄMPFUNG

Von *Wolfdietrich Eichler*

Aus der Forstentomologie lässt sich heute die Flugzeugstäubung nicht mehr wegdenken. Auch in der landwirtschaftlichen Schädlingsbekämpfung bürgert sich die Verwendung des Streuflugzeuges mehr und mehr ein. Als dritte Domäne hat es sich in den letzten beiden Jahrzehnten auch die Malariabekämpfung erobert, wobei die Verwendung teils als Stäube-, teils als Sprühmaschine erfolgt. Die in dieser Hinsicht vor einigen Jahren von deutscher Seite angestellten Versuche wurden zwar mit den für die Zwecke der Malariabekämpfung ungeeigneten Forstschutzflugzeugen durchgeführt, doch gelang es mir, dank der Heranziehung russischer Erfahrungen und Veröffentlichungen, eine schärfere Umreissung der Indikationsstellung zur Anwendung von Flugzeugstäubungen in der Malariabekämpfung auszuarbeiten. Sie wird vor allem von der Praxis gefordert werden, da in der Larvenbekämpfung der Flugzeugeinsatz grundsätzlich immer nur eine Ausnahmeerscheinung sein kann.

Dies hängt in erster Linie damit zusammen, dass sich die Brutgewässer für *Anopheles*-Larven in für eine Malariaepidemie wesentlicher Bedeutung meist in unmittelbarer Nähe von Siedlungen befinden. Ihre Ausdehnung ist in der Regel weit geringer, als häufig angenommen wird, und zumeist ist eine ausreichende Bearbeitung schon durch Massnahmen vom Boden aus möglich.

Erst bei sehr grossem Ausmass der anophelogenen Fläche kann also in besonderen Fällen der Einsatz von Flugzeugen lohnend erscheinen oder sogar notwendig werden. Dies setzt allerdings eine *sorgfältige Prüfung der tatsächlichen Anophelogenität* voraus. Meistens beschränkt sich nämlich auch in grossen Sumpfgebieten die anophelogene Zone auf den Randabschnitt. Selbst bei flächig ausgedehnter Larvenbesiedlung grosser Sümpfe nimmt nach dem Innern zu in der Regel die Besiedlungsdichte rasch ab, bis ihr keine epidemiologische Bedeutung mehr zukommt.

Die laienhafte Vorstellung einer kausalen Wechselbeziehung „viele Malariafälle: also Hilfe durch Flugzeugstäubung“ liegt zwar auch für den Arzt nahe, ist jedoch grundfalsch. Flugzeugstäubung soll schon aus wirtschaftlichen Gründen erst dann erwogen werden, wenn andere Massnahmen nicht ausreichen oder nicht angewandt werden können. Ausserdem setzt sie eine epidemiologische Prüfung der Malarialage (Gameten-träger, Übertragungsmöglichkeiten, epidemiologische Anamnese der Bevölkerung) sowie der Mückenlage voraus, sowie selbstverständlich eine eingehende biologische Untersuchung der Brutgewässer.

Weyer hat eine Reihe recht brauchbarer Kriterien dahingehend zusammengefasst, dass es sich um ein umfangreiches Brutgebiet handeln müsse, welches weder mit einfachen Mitteln schnell zu entwässern, noch von Hand aus zu bestäuben sei. Schliesslich soll dann noch das ganze Gelände möglichst frei und übersichtlich sein und wenig Bäume und Büsche enthalten, weil sonst der Giftstaub nicht in ausreichendem Masse aufs Wasser gelangt.

Wesentlich eingehender hat sich N a b o k o v mit diesen Fragen beschäftigt. Er berichtet zunächst, dass in der Sowjetunion die Flugzeugstäubung gegen Anophelen hauptsächlich angewandt worden sei in Gebieten mit Baumwollanbau (Turkestan), in

Reisgebieten (Kolchosen und Sowchosen), in Torfgebieten, in Flussniederungen oder Versumpfungsbereichen unweit grosser Industriezentren, sowie endlich in Gebieten mit einem Netz anophelogener Gewässer von hoher epidemiologischer Bedeutung. Ein Argument für die Flugzeugstäubung sei immer eine hohe *absolute* Erkrankungsziffer, während sich Flugzeugstäubung in ausgedehnten Flussniederungen mit *dünnere* Besiedlung ökonomisch *nicht* lohne. Dieser *wirtschaftliche Gedankengang* ist auch massgebend für die Überlegung, ob die Bevölkerung eines Gebietes durch Prophylaxe und Therapie 100%ig erfasst werden kann oder nicht: im ersteren Falle ist nämlich immer die medikamentöse Versorgung billiger. Dagegen sei in intensiv bewirtschafteten Gebieten die Flugzeugstäubung „besonders rentabel“, weil hier die Gebietserträge genügend abwürfen, um solch hohen Aufwand zu rechtfertigen.

Besonderen Wert legt N a b o k o v mit Recht auf das *Verhältnis zur Bodenbearbeitung*, die immer an erster Stelle zur Diskussion stehe. Erst wenn es nicht mehr möglich ist, alle larventrächtigen Gewässer durch Bodenarbeit zu erfassen, rückt die Flugzeugstäubung in den Vordergrund. Vor allem gilt dies in vielen landwirtschaftlich besonders wichtigen Ländereien oder in Industriegebieten, während in grossflächigen Flussauen dann die Flugzeugstäubung schliesslich oft die einzig mögliche Methode wird. In Torf-, Baumwoll- und Reisgebieten bleibt die Flugzeugstäubung immer noch die wichtigste Methode neben den Bodenarbeiten, während ihr z. B. in Staubecken nur der Charakter einer Zusatzmethode neben den Bodenmassnahmen zukommt.

Auf der anderen Seite lohne sich Flugzeugstäubung überhaupt nicht: 1. in zwar wasserreichen, aber dünn besiedelten Landstrichen; 2. in Gebieten, in denen die technische Durchführung scheitert (hohe Bäume, Brücken, zerschnittene oder steile Ufer usw.); 3. wenn alle Brutstätten vom Boden aus zugänglich sind.

Ein weiterer wesentlicher Punkt ist die Verfügbarkeit von *genügend Hilfskräften*. Im Normalfalle wird die Flugzeugstäubung parallel zu Bodenmassnahmen durch Bonifikatoren durchgeführt werden, sei es dass neben dem durch Flugzeugstäubung sanierten Gewässer noch weitere anophelogene Flächen anderen Charakters von Hand aus bearbeitet werden, sei es dass ein Stab von Bonifikatoren bereitstehen muss, um unvorhergesehene oder unvermeidbare „Versager“ der Flugzeugstäubung zu korrigieren (Streufehler, Abtrift, Gelände Hindernisse). Auf jeden Fall sollen aber einige Hilfskräfte die Larven- und Mückenkontrollen vornehmen können, damit die Flugzeugstäubung nicht zur blossen Massnahme auf Verdacht herabsinkt. Diese Gefahr ist besonders deshalb leicht gegeben, weil sie ja in dringenden Fällen ausserordentlich schnell anlaufen kann.

Damit sind wir aber schon bei der *Kostenfrage* der Flugzeugstäubung angelangt. Leider lässt sich die Gradation der Anophelen noch nicht so weit beherrschen, um durch Herausschneiden bestimmter Generationen den epidemiologisch entscheidenden Schwellenwert der Mückenzahl zu begrenzen. Wir müssen daher im allgemeinen in der Malariaabwehr eine notwendige Brutplatzbekämpfungsmassnahme die ganze Larvensaison über beibehalten. Obwohl an sich durch den Einbau der Bestäubungsapparatur jedes beliebige Flugzeug mit geringen Kosten zu einem Streuflugzeug umgebaut werden kann, werden sich in der Praxis doch ausserhalb der Malariasaison für die eingesetzten Streumaschinen sowie das mit ihr verbundene Spezialpersonal keine Verwendung ergeben, sodass rechnerisch die materiellen Kosten für Haltung und Wartung des Flugzeugs einschliesslich der personellen Kosten für das Streukommando für jede Malariasaison auf ein volles Jahr getragen werden müssen. Hinzu kommt gegebenenfalls An- und Abtransport des Streukommandos zu Beginn und Ende der Streuperiode.

Weitere feste Kosten sind die personellen Kosten für Bestäubungsleiter und Entomologe wie der von diesen benötigten Fahrzeuge, ferner die Kosten für Sieb- und Mischgeräte, sowie Schutzbekleidung und sonstige Giftschutzmassnahmen.

Die *laufenden Kosten* hängen ab von der Grösse des zu bearbeitenden Streufeldes und der Zahl der notwendigen Bestäubungsfolgen. Hierbei sind als Einzelposten beteiligt die Kosten für das Gift (einschliesslich dessen Antransport), die Kosten für Herstellung und Antransport des Füllstoffes (z. B. Strassenstaub), die Kosten für Mischen des Streugutes und Beladen der Flugzeuge, die Kosten für die Flugkilometer (Bestäubungsflüge einschliesslich An- und Abflug), sowie schliesslich die Kosten für die Kennzeichnung und gegebenenfalls Absperrung des Geländes. Bei der russischen Flugzeugstäubung (unter Friedensverhältnissen bei gut eingespieltem Betrieb und Gegebensein aller technischen Voraussetzungen) wurde die Zeit zur Wendung zum nächsten Streifen mit 30 Sekunden angesetzt, die Staubverladezeit mit 2 Minuten, die tägliche Arbeitszeit des Flugzeuges mit 4 Stunden, wobei sich — unter Zugrundelegung einer toxischen Breite je Streifen von 100 m und eines Mischungsverhältnisses von 1:1 — pro Stunde eine Arbeitsleistung von 300 ha ergibt.

Das zwar psychologisch verständliche, aber sachlich bedauerliche Bestreben, das nun einmal für die ganze Saison an dasselbe Brutgewässer gebundene Flugzeug in den Zwischenzeiten zwischen den Streuflügen nicht unausgenutzt herumstehen zu lassen — besonders dann, wenn das Flugzeug-Spezialpersonal nur zum Fliegen und nicht (wie in Russland) zweckmässigerweise nebenbei noch zur Bereitstellung des Streugutes herangezogen wird — dieses Bestreben führt leicht zur Suche nach weiteren stäubbaren Brutplätzen und auf diese Weise entweder zur Heranziehung von Gewässern, deren Flugzeugbearbeitung sonst nicht erwogen worden wäre, oder (bei Bearbeitung entfernterer Plätze) zu einer Vergrösserung des Anflugweges. Diese der Flugzeug-Malariabekämpfung noch anhaftende Neigung zur Kostenerhöhung ist z. T. traditionell aus der Forstschädlingsbekämpfung übernommen, wo sowohl rechnerisch andere Gesichtspunkte massgebend sind als in der Hygiene: wie auch die epidemiologischen Grundlagen (Beziehung der Gradation der Forstinsekten zur Schadenentstehung) sich völlig andersartig verhalten.

Doch soll mit dieser Kritik beileibe nicht gesagt sein, dass das Flugzeug in der Malariabekämpfung ausser für die notwendigen Streuflüge überhaupt nicht eingesetzt werden solle. Vielmehr geben sich eine Reihe wichtiger *Nebenaufgaben im Erkundungsdienst*, neben der Beobachtung während der Stäubflüge z. B. zur Geländeaufnahme. In Malariagegenden sind oft keine grossmassstäbigen oder doch nur unzuverlässige Karten vorhanden, ausserdem kann z. B. in Küstengebieten sich die Verteilung von Land und Wasser in wenigen Jahren ganz erheblich ändern. Luftbildaufnahmen können dann die Karte ersetzen, oder es kann an Hand der Luftaufklärung die Karte kontrolliert und ergänzt werden. In gleicher Richtung liegt auch die Verwendung des Flugzeuges zur Planung und Überwachung von Bodenregulierungs- und Entwässerungsmassnahmen zur Malariaassanierung eines Gebietes. Dagegen muss dringend vor der Auffassung gewarnt werden, als ob Brutplätze vom Flugzeug aus bestimmt werden könnten.

Was die *Festsetzung der Stäubetermine* betrifft, so ist zu beachten, dass der zahlenmässig schwachen ersten Larvengeneration als entscheidendem Faktor für die Jahresgradation epidemiologisch die grösste Bedeutung zukommt. Es darf daher nicht gewartet werden, bis genügend Larven vorhanden sind, damit sich eine Stäubung auch lohne, sondern diese soll durchgeführt werden, sobald überhaupt die ersten Larven des Jahres erscheinen. In Malariagebieten zweitrangiger Bedeutung ist man daher

gelegentlich dazu übergegangen, durch einen einmaligen Stäubungsflug im zeitigen Frühjahr lediglich die erste Generation (oder wenigstens ihre Entwicklungsspitze) abzuschneiden. Die Erwartung eines vollen Erfolges des Flugzeugstäubung fordert allerdings ihre Durchführung während der ganzen Brutsaison (worauf ja oben bei Besprechung der Kostenfrage schon hingewiesen wurde).

Zur Berechnung eines äussersten Wiederholungstermins — wobei in der Flugzeugstäubung für den Fall einer unvorhergesehenen Verspätung der Flüge bzw. des Ausfalls eines Streuflugzeuges noch ein Sicherheitsfaktor von einem Tage eingerechnet werden soll — ist davon auszugehen, dass ältere Viertlarven (Vorpuppenstadium) nicht mehr fressen, in Fällen der Verwendung eines reinen Frassgiftes (z. B. Schweinfurter Grün) also der Stäubungsflug wenigstens noch junge bis mittlere Viertlarven treffen soll (bei manchen Kontaktgiften werden vielleicht sogar die Puppen noch von der Giftwirkung erfasst). Diese entomologische Forderung deckt sich ungefähr mit der russischen Faustregel „die Stäubung wird angeordnet, wenn Drittlarven auftreten“. Denn beim durchschnittlichen Auftreten von Drittlarven — nach Feststellungen der Bonn beim durchschnittlichen Auftreten von Drittlarven — nach Feststellungen der Bonifikatoren (Malariaabekämpfungs-Facharbeiter), nicht des Entomologen — kann ja damit gerechnet werden, dass gleichzeitig an zwar nicht beobachteten, aber doch sicher existierenden entwicklungsbevorzugten Stellen bereits junge Viertlarven vorhanden sind, und nach Anordnung des Fluges bis zu seiner Ausführung werden ja doch noch wenigstens Stunden vergehen. Ein Miterfassen solcher Entwicklungsspitzen an „entwicklungsbevorzugten Punkten“ muss jedenfalls angestrebt werden. Dies wird allerdings vielfach automatisch auch dann erfolgen, wenn diese Stellen übersehen worden waren, da die Proterandrie einen automatischen Sicherheitsfaktor darstellt. Pagast hat nämlich (nach mündlicher Mitteilung) in verschiedenen Zuchten einer *Anopheles*-Art aus der *maculipennis*-Gruppe festgestellt, dass sich das Schlüpfen der Mücken auf einen Zeitraum von vielen Stunden erstreckt. Die ersten erscheinenden Imagines sind jeweils Männchen, bald folgen dazwischen auch einzelne Weibchen, und die gegen Schluss schlüpfenden Mücken sind dann ausschliesslich Weibchen. Ob allerdings auch die Entwicklungsspitzen der Larvenfraktionen jeweils Männchen sind, kann vorläufig nur vermutet werden.

Zur genaueren *Bestimmung der Entwicklungsgeschwindigkeit* hat Bodenheimer eine Formel aufgestellt, die auch von Nabokov benützt wird (vgl. Pagast & Eichler 1944). Nach ihr kann man für jeden Temperaturbereich innerhalb der üblichen *maculipennis*-Bruten die Dauer der einzelnen Stadien berechnen. Zusammen mit Pagast habe ich die praktische Brauchbarkeit der Formel für den Temperaturbereich von  $25-25\frac{1}{2}^{\circ}\text{C}$  geprüft und dabei eine recht gute Übereinstimmung hinsichtlich des ersten Auftretens der einzelnen Larvenstadien bei einer Zimmerkultur gefunden. Die gleichwertig vorgenommene Larvenanalyse im Freiland ergab jedoch an entwicklungsbevorzugten Punkten ein erhebliches Vorseilen. So sollten die ersten Viertlarven nach der Bodenheimerschen Formel nach 6 Tagen auftreten, in der Zimmerzucht wurden sie nach 6 Tagen und 11 Stunden beobachtet, im Freiland dagegen bereits nach 4 Tagen und 10 Stunden festgestellt (vgl. Eichler & Pagast 1949). Es wird sich also bis zu einer theoretischen Untermauerung dieser Erscheinung vorläufig noch empfehlen, die Terminbestimmung weiterhin den Larvenanalysen z. B. in Algenkissen zu überlassen. In der Praxis hat sich hierbei ergeben, dass der Abstand der Stäubeflüge z. B. in Südrussland während einer Saison von zunächst 14 Tagen bis auf nur 6 Tage herabgesetzt werden musste.



Ferner hat sich als zweckmässig erwiesen, als *Tageszeit* der Stäubung die frühesten Morgenstunden zu wählen. Am geeignetsten ist etwa 10—15 m vor Sonnenaufgang. Nur in Reisgebieten soll während der Reisblüte abends geflogen werden, da der Arsenstaub wegen des Taus die Blüten schädigen kann.

Was die Aufstellung des Bekämpfungsplanes im einzelnen anbelangt, so sei betont, dass die Einzeichnung der anophelogenen Gewässer in eine *hydrographische Karte als Grundlage des Bekämpfungsplanes* erst nach gründlicher Untersuchung eines Gebietes statthaft ist, weil sonst leicht eine zu grosse Schematisierung der Bekämpfungsarbeit begünstigt wird. Hierbei muss daran gedacht werden, dass die ersten Generationen häufig zahlenmässig noch schwach sind und daher übersehen werden können, zudem möglicherweise oft recht scharf abschneiden, sodass bedeutsame anophelogene Gewässer im Frühjahr zu gewissen Zeitpunkten völlig larvenfrei erscheinen mögen. Andererseits können die Anophelen entsprechend den geographisch-limnologischen Saisonschwankungen im Laufe des Sommers mehrfachen Brutplatzwechsel vornehmen.

Die Ausführung der zur Terminprognose bestimmten Larvenanalyse entspricht technisch der auch als Erfolgskontrolle vorgenommenen Schöpfprobenentnahme im Querschnitt der anophelogenen Fläche. Doch können nicht beide Larvenanalysen vereint werden, sondern müssen zu verschiedenen Zeiten erfolgen. Der günstigste Zeitpunkt der *Probenentnahmen für Erfolgskontrollen* ist im allgemeinen so zu wählen, dass höchstens einige junge Zweitlarven (der neuen Generation) anwesend sein sollen; bei einem noch früheren Termin hätte das Gift vielleicht noch nicht genügend gewirkt. Bei Proben für die Terminprognose sollen dagegen möglichst schon einige junge Viertlarven anwesend sein.

Aus verschiedenen technischen und organisatorischen Gründen wird es in der Regel wünschenswert sein, den Termin der nächsten Stäubung nicht erst von dem Ergebnis der auf den Flug folgenden Larvenanalysen abhängig zu machen, sondern ihn spätestens während des akuten Bestäubungsfluges bekanntzugeben. In der Praxis verfuhr ich dabei so, dass ich infolge auswärtiger Stationierung der Streuflugzeuge nun während des Bestäubungsfluges neben den Mann, der durch Rauchmunition (Bodenrauchzeichen, gelegentlich auch Rauchbündelpatronen oder Rauchballmunition) die Lage des Streufeldes abgrenzte, weisse Bettücher auslegte, die die Zahl der Tage anzeigte, nach welchen der nächste Streuflug stattfinden sollte. Die Larvenanalyse zur Terminfestsetzung diene also der Prüfung der Prognose und konnte höchstens die darauffolgende Terminbestimmung beeinflussen. Bis zur Ablesbarkeit der Terminprognose aus den meteorologischen Daten werden jedenfalls noch viele Untersuchungen notwendig sein.

Diese hier aufgezählten Gesichtspunkte gründen sich auf Erfahrungen an Anophelen der *maculipennis*-Gruppe (hauptsächlich wohl *Anopheles messeae*). Es liegt auf der Hand, dass sie modifiziert werden müssen, sobald wir es mit einer anderen Überträgerart zu tun haben. Denn nicht nur deren Brutgewohnheiten, sondern vor allem auch deren Malariaaffinität ist letztlich entscheidend für die Art der durchzuführenden Massnahmen. Hinsichtlich der Terminfestsetzung spielt dann die Entwicklungsdauer die ausschlaggebende Rolle. Auch hier liegen für die *messeae*-Gruppe grundlegende Erfahrungen vor, während für andere Formen durchaus verschiedene Daten gelten mögen.

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## SALZWASSERVERTRÄGLICHKEIT UND SOMMERPHASE DES ANOPHELES ATROPARVUS

Von *Wolfdietrich Eichler*

Die Brutplätze des *Anopheles atroparvus* zeichnen sich durch mehr oder minder grossen Salzgehalt aus. Auch wo sich die Larven in geschmacklich reinem Süsswasser entwickeln, ist die Beziehung zu salzhaltigen Böden und halophilen Pflanzen so deutlich, dass bereits diese ökologische Beziehung die offenbare Notwendigkeit einer wenigstens spurenweisen Anwesenheit von NaCl vermuten lässt. *Anopheles atroparvus* kommt daher vor allem in den brackigen Regionen der europäischen Küsten vor, gleichzeitig jedoch auch im Binnenlande dort, wo sich salzige Gewässer finden.

Einen im russischen entomologischen Schrifttum schon seit langem bekannten Binnenbrutplatz des *Anopheles atroparvus* stellt der südlich des Dorfes Ssolënj gelegene zu- und abflusslose Janowskowo-See dar. Vom südlichen Westausläufer des Achtanowskij Liman — welcher zwar rein süss ist, aber in dieser Gegend keine Mückenbrutplatzmöglichkeiten bietet — ist er durch eine breite (dammartige) natürliche Geländeerhöhung scharf getrennt, auf welcher die Strasse von Achtanowskaja nach Starotitarowskaja führt.

Der Janowskowo-See ist infolge seines hohen Gehaltes an Magnesiumsulfat als Bittersalzsee allgemein bekannt. Die winterliche Wasserführung versüsst ihn so weit, dass er im Frühjahr einen geeigneten *atroparvus*-Brutplatz darstellt. Zum Sommer hin wird er dagegen stark eingedickt, sodass er infolge seines jetzt zu hohen Salzgehaltes den Larven keine Entwicklungsmöglichkeit mehr bieten kann. Er zeigt dann starke Abwechslung zwischen nackten Wasserflächen (die stellenweise mit Krautrasen gemustert sind) und Wäldern vertikaler Vegetation (z. B. *Phragmites*). Wegen des tiefen schwarzen Schlicks kann man dann fast nirgends ohne tiefes Einsinken bis an den Rand der Wasserfläche gelangen und auch im Innern des Sees nur mühsam mit Gummistiefeln umherwaten. Andere Anophelenbrutmöglichkeiten sind in der näheren und weiteren Umgebung des Janowskowo-Sees zumindest während des Sommers auf viele Kilometer hin nicht gegeben.

Das Wasser des Janowskowo-Sees schmeckt deutlich salzig mit bitterem Nebengeschmack. Es ist von vielen organischen Verunreinigungen durchsetzt, grünlich-gelb gefärbt, und riecht stark nach Schwefelkohlenstoff. Eine Ende August 1943 entnommene Wasserprobe gab ein pH von 7,8—8,1 und einen Salzgehalt von 2,17 ‰. Nach Geschmack und Stand der Wasserführung muss dieser schon Anfang Juli gleich hoch gewesen sein. Chloride waren 17 gr/l enthalten, Sulfate 1,83, Calcium 0,48, und Magnesium 0,83 gr/l. Als Ionenreaktionen waren Cl und Na stark positiv, SO<sub>4</sub>, Ca und Mg positiv, während PO<sub>4</sub> und Fe in Spuren nachgewiesen wurden, NH<sub>4</sub> und Al in geringen Spuren, und K in äusserst geringen Spuren. Die Reaktionen auf NH<sub>3</sub>, NO<sub>3</sub> und NO<sub>2</sub> waren negativ. Unterschiede gegenüber dem Meerwasser bestehen also u. a. in geringerem Salzgehalt (2,17 ‰ gegenüber 3,33 ‰) bei besonders hohem Magnesiumsulfatanteil (wahrscheinlich ist allerdings das Magnesium hier auch als Chlorid anwesend).

Die Mückenzahlen waren ausserordentlich hoch. In einem einzelstehenden Haus südlich der Seemulde wurden am 11. VII. 1943 im Hausflur (von 2 m Höhe und

4 qm Grundfläche) 433 *Anopheles*-Imagines gezählt (meist Weibchen, auch Männchen). An windstilleren Tagen soll dort die Mückenanzahl noch höher sein. In Ssolënij selbst fanden sich in mehreren Häusern in verschiedenen Teilen des Dorfes fast ebensolche Mückenzahlen, die nach über fünf Wochen gleich hoch geblieben waren. Auffallend war dabei der hohe Wert des Männchenanteiles.

Bei den Mücken handelt es sich offenbar um ein isoliertes *atroparvus*-Vorkommen inmitten reiner *messeae*-Populationen. Die im Dorfe Ssolënij Ende August gefangenen Weibchen legten im Laboratorium nach drei Tagen Eier ab. Auch noch später gefangene Weibchen konnten ohne Schwierigkeiten zur Eiablage gebracht werden. Die Eier sämtlicher Gelege von Ssolënij-Mücken zeigten alle den einheitlichen *atroparvus*-Typ, ähnlich gezeichnet wie ihn die Abbildung bei Peus darstellt. Vor allem stimmten die gerade Abgrenzung der Kammern und die allgemeine Eiform (schlank!) gut mit der Zeichnung von Peus überein. Dagegen waren die Kontraste geringer (nur dunkelgrau auf grau!).

Zur Eiablage bot ich reines Brunnenwasser, angefeuchteten Zellstoff, und Wasser originaler Janowskowo-Abfüllung. Auf letzterem erhielt ich nur ein einziges Gelege, dessen Eier völlig weiss und klein waren. Es steht hierbei jedoch nicht fest, ob es sich um ein Notgelege unentwickelter Eier handelt oder um zwar normal abgelegte, aber nicht gequollene und nicht ausgefärbte. Die Mehrzahl aller Gelege wurde auf Brunnenwasser abgelegt, jedoch einige auch auf den (ebenfalls mit Brunnenwasser) angefeuchteten Zellstoff.

Die Eier, die ich in Brunnenwasser liegen liess oder einbrachte, schlüpften nach 2 Tagen völlig normal. Dagegen waren einige auf Brunnenwasser abgelegte und dann auf leicht eingedicktes Janowskowo-Wasser (von etwa 2,65 ‰ Salzgehalt) gebrachte Eier zwar geschlüpft, aber unmittelbar darauf abgestorben (Larven klein, geschrumpft, fast völlig weiss, nur in wenigen Fällen etwas gedunkelt). Dass sich also die Larven in der im Sommer im Janowskowo-See herrschenden hohen Salzkonzentration nicht entwickeln können, entspricht durchaus auch den Freilandbefunden, da ja im See weder am 11. VII. noch am 17. VIII. *Anopheles*-Larven gefunden wurden (wohl allerdings *Culex*-Larven am 17. VIII.).

Um eine genauere Vorstellung über die noch larvenholde Grenzkonzentration zu erhalten, brachte ich am 3. IX. aus den vermischten Brunnenwasser-Gelegen der Ssolënij-Mücken je 40 Eier auf 5 verschiedene Zuchtschalen und beobachtete die weitere Entwicklung. Die verschiedenen Fraktionen stellten 0, 15, 25, 40 und 70 ‰ige Konzentrationen von Janowskowo-Wasser in Brunnenwasser (gefiltertem Kuban-Wasser) dar. Die Zuchten wurden im Zimmer bei rund 25 ° C gehalten, reichlich mit Piscidin gefüttert, nach Möglichkeit gut gepflegt, u. a. tagsüber gelegentlich der Sonne ausgesetzt, ferner mit Schlamm und Pflanzenresten versorgt und häufig umgerührt. Die Einbringung von Schlamm wurde hierbei deshalb gewählt, da nach Eckstein 1939 die Anwesenheit von Erde oder insbesondere Tonen im Brutgewässer eine günstige — weil die Oberfläche reinigende — Wirkung auf die Aufzucht von *Anopheles*larven hat. Grundsätzlich wurden alle 5 Gläser möglichst gleichartig versorgt. Zur Kompensation der Verdunstung wurden die 200 ccm Flüssigkeits-Soll der Zuchtschale im Bedarfsfalle jeweils mit Brunnenwasser wieder aufgefüllt.

Der genaue Verlauf der Larvenentwicklung wurde nun durch regelmässige Kontrollen nach der Methode von Eichler & Pagast 1948 verfolgt (Auszählung der Larvenstadien mit Differenzierung nach Jung- und Altlarven desselben Stadiums). Hierbei wurde besonders geachtet auf Schlüpfquote, Sterbequote und Spitzenquote

(Entwicklungsgeschwindigkeit), da ich diese Werte als besonders brauchbare Indikatoren für die optimalen Entwicklungsbedingungen von *Anopheles*-Larven ansehe. Für die verschiedenen Zuchtschalen ergab sich dabei dann folgendes Bild:

a. Im reinen Süßwasser (0<sup>0</sup>/oiges Janowskowo-Wasser; Aräometerwert 1.000) sind die Larven von Anfang an recht beweglich und eilen mit ihrer Entwicklungsspitze zunächst allen anderen Zuchten voraus. Erst später werden sie dann von der b-Zucht überflügelt.

b. Im 0,32<sup>0</sup>/oigen Salzwasser (15<sup>0</sup>/oiges Janowskowo-Wasser, entspricht etwa 10<sup>0</sup>/oigem Meerwasser, d. h. unter Beziehung auf den bloss absoluten Salzgehalt; Aräometerwert 1.003) war die absolute Zahl der Larven allen anderen Zuchten überlegen und überflügelte in der Entwicklungsspitze bald auch die a-Zucht.

c—d. Im 0,54 und 0,87<sup>0</sup>/oigen Salzwasser (25 bzw. 40<sup>0</sup>/oigen Janowskowo-Wasser, entspricht etwa 16 bzw. 26<sup>0</sup>/oigem Meerwasser; Aräometerwerte 1.005 bzw. 1.008) zeigt sich anfänglich eine ganz deutliche Verlangsamung der Entwicklung, die sogar in der Beweglichkeit der Larven auffällig ist. Die älteren Larven entwickeln sich dagegen bei diesen höheren Konzentrationen besser. Auch der 0,87<sup>0</sup>/oige Salzgehalt bietet also immerhin noch Entwicklungsmöglichkeiten.

e. Im 1,52<sup>0</sup>/oigen Salzwasser (70<sup>0</sup>/oiges Janowskowo-Wasser, entspricht etwa 46<sup>0</sup>/oigem Meerwasser; Aräometerwert 1.014) beobachten wir eine geringe Schlüpfquote (nur 15 geschlüpfte Larven gegen 39 in der b-Zucht und nirgends unter 34 in den anderen) sowie starke Bewegungshemmung der jungen Larven und Absterben aller Erstlarven vor der Häutung zur Zweitlarve.

Zusammenfassend ziehe ich aus meinen oben dargelegten Feststellungen vor allem folgende Schlüsse:

1. Die Mücken des *Anopheles atroparvus* wählen solche Salzkonzentrationen aus, die noch eine Larvenentwicklung ermöglichen. Stehen ihnen diese nicht zur Verfügung, so legen sie keine Eier ab.

2. Beim Steigen der Salzkonzentration des allein zur Verfügung stehenden Brutgewässers über die larvenholde Grenzkonzentration hinaus infolge zunehmender Austrocknung wird die Eiablage unterbrochen, und die Weibchen nehmen weitere Blutmahlzeiten vermutlich nur gelegentlich zur Aufrechterhaltung des Betriebsstoffwechsels zu sich. Während dieser durch die sommerliche Hitze gesteuerten „Sommerphase“ können jedoch sowohl Weibchen wie auch Männchen eine Reihe von Wochen lang leben.<sup>1</sup> Im vorliegenden Falle dürfte es sich um wenigstens ein Vierteljahr gehandelt haben.

3. Hieraus folgert auch eine recht geringe Generationenzahl im Laufe eines Sommers. Da die Mücken der ersten Generation des *Anopheles messeae* im Berichtsjahre etwa Mitte Mai geschlüpft waren, konnte es sich weder bei analogen Entwicklungsverhältnissen noch bei den Ende August gefangenen Mücken um solche der zweiten Generation gehandelt haben. Es müsste unter diesen Umständen sogar damit gerechnet werden, dass *Anopheles atroparvus* am Janowskowo-See jährlich nur ein bis zwei Generationen erzeugt. Denn es ist nicht sicher, ob die erst im späten Herbst zu erwartende Aussüßung des Sees rechtzeitig genug kommt, um noch einmal eine Mückengeneration hervorzubringen.

<sup>1</sup> Es erscheint mir recht fraglich, ob sich die mögliche Langlebigkeit von *Anopheles*-Mücken unter Laboratoriumsverhältnissen beim gegenwärtigen Stande der Haltungstechnik überhaupt nachprüfen lässt.

4. Bei Wiedereintreten von eiablagegünstigen Bedingungen bzw. Angebot einer larvenholden Salzkonzentration findet wieder eine Eiablage statt.

5. Im 0,32<sup>0</sup>/oigen Salzwasser der Zusammensetzung des Janowskowo-Sees entwickeln sich die *atroparvus*-Larven besser als im reinen Süßwasser oder im 0,54<sup>0</sup>/oigen Salzwasser. Mit zunehmendem Larvenalter steigert sich auch die noch vertragene Salzkonzentration. Auch das 0,87<sup>0</sup>/oige Salzwasser bietet noch günstige Entwicklungsmöglichkeiten, wogegen die im 1,52<sup>0</sup>/oigen geschlüpften Larven darin nach kurzer Zeit absterben.

6. Die Steigerung der Salzverträglichkeit mit zunehmendem Alter der Larve könnte vielleicht zu den Freilandverhältnissen in Parallele gesetzt werden, unter welchen ja gleichzeitig eine Eindickung des Brutgewässers erfolgt.

7. Die *atroparvus*-Kolonie des Janowskowo-Sees ist eine isolierte *atroparvus*-Population inmitten einer *messeae*-Region. Ein Austausch der Anophelen auf weite Entfernungen scheint in nennenswertem Umfange nicht stattzufinden, da sich unter den *Anopheles*-Gelegen aus Ssolënj keine *messeae*-Eier<sup>2</sup> befanden. Dieser Gesichtspunkt ist vor allem auch für die *Anopheles*-Bekämpfung von Bedeutung.

8. Die Struktur der Eier der Ssolënj-Mücken erweist ihre Zugehörigkeit zum *atroparvus*-Formenkreis. Ob die am Ei festgestellten besonderen Merkmale für die Ssolënj-Population charakteristisch sind und eventuell die Abgrenzung einer eigenen geographischen Rasse aus Südrussland ermöglichen, lässt sich vorläufig noch nicht beurteilen.

<sup>2</sup> Über deren Kennzeichen in dem betreffenden Gebiet wird an anderer Stelle berichtet werden.

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## BULLIS FEVER

By Charles H. Morhouse and Dwight M. Kuhns

Snyder's (1) classification of Rickettsial Diseases lists five separate groups of which the last one is designated as a miscellaneous group of unrelated diseases and includes North Queensland Tick Fever, Trench Fever and Bullis Fever.

Bullis Fever derives its name from Camp Bullis which is a military reservation some twenty miles north of San Antonio, Texas. This area has a mean elevation of 1200 feet (365 meters) and an area of 30,500 acres (123,000,000 square meters) of which part is a federal game reserve. Vegetation is abundant with junipers, thorny shrubs, vines and tall grasses predominating. Animal life of all kinds is prevalent and several hundred species have been described with the white-tailed deer, jack rabbits, turkey buzzards and rattlesnakes being the most common. Twelve species of ticks have been found in the area but the Lone Star or *Amblyomma americanum* far exceeds all others in numbers. One cannot walk through certain areas without becoming literally covered with them. Nine hundred and ten have been removed from the head of one deer and over 1200 were picked from one jack rabbit. The area is semiarid with less than 25 inches of rainfall per year and is, because of its isolation and restricted nature, well suited for animal and insect propagation.

*Amblyomma americanum* is a relatively small hard tick, with a considerable variation in size and also with an unusual disparity between the smaller males and larger females. The female possesses a single white spot in the center of the scutum (back) from which the name "Lone Star Tick" is derived. The male does not possess this white spot but is ornamented by irregular white markings, usually near the margins of the back. The larvae and nymphs are unmarked but present a shiny brown appearance. The range is eastward and northward from the southernmost tip of Texas to the southern portions of the northern New England States. However, such evidence as we have suggests that it is extremely scarce in the northern portion of this area. It is most abundant, and less sporadically, in the Southern States along the Gulf Coast. All stages have long mouth parts and crawl with amazing speed for ticks. In its habitat it has been shown to carry Rocky Mountain Spotted Fever and has produced American Q Fever and tularemia (*Pasteurella tularensis*) in laboratory animals. *A. americanum* is a three host tick and the engorged larvae and nymphs drop from the host for molting. Mating usually takes place on the host and thus all stages of ticks may be found on one host.

The Clinical entity which is now called Bullis Fever was first seen in the Spring and early Summer of 1942 at Brooke General Hospital, Ft. Sam Houston, Texas (2). These cases, all undiagnosed on admission, exhibited several characteristic clinical features. White blood count was usually low with a moderate neutropenia, fever was moderate, severe post orbital and occipital headache common, either local or generalized adenitis and all gave history of tick bites while on some, ticks were found on admission. When this occurred all were noted as being Lone Star ticks. All patients were soldiers who had been on field exercises at Camp Bullis. Because of a lack of diagnosis and suspecting the nature of the disease, Drs. Maxcy, Topping and Snyder of the Army Epidemiological Board came to San Antonio in July 1942 and after

examination of the records and the few remaining cases gave the syndrome a tentative designation of "Tick Bite Fever probably caused by rickettsia."

A typical case of Bullis Fever usually had a sudden onset with an initial chill followed by fever of 102—105 F. Headache was common and lassitude, prostration and general malaise universal. Fever lasted up to two weeks, treatment was symptomatic and no deaths occurred.

Physical examination and laboratory work were most disappointing. Adenitis either general or local, tick bite scars and a rash in about 10% of the cases was noted. The rash in the severe cases appeared to be like rubella or in some like flea borne typhus (endemic). Low white counts were all that was found by laboratory procedure—culture and agglutination tests such as Weil-Felix and heterophile gave negative results.

Livesay and Pollard (1943) working with clinical cases of this new disease were able to obtain from bacteriologically-free material from parietal peritoneum and spleens of laboratory animals, stained by Machiavello technic, small red staining rods and oocoid bodies in cytoplasm and nuclei. From biopsy specimens of enlarged axillary lymph nodes in two cases of Bullis Fever using moist impressions and staining by the above method small intracellular fuchsinophilic granules and rods similar to rickettsia were again found. Serial passage through male guinea pigs showed no increase in virulence and no orchitis.

Of the clinical entities which require differentiation from the syndrome which was designated as "tick bite fever" we naturally think of the other rickettsial diseases such as Rocky Mountain Spotted Fever, Endemic Typhus which is not uncommon in Southwest United States, Q Fever, Colorado Tick Fever, Dengue Fever, and one of us (Kuhns) feels the blood picture resembles very closely that of one type of infectious mononucleosis. In this connection it might be pointed out that for many years Colorado Tick Fever, which is probably a virus rather than a rickettsial disease, was known in the United States as "tick borne dengue."

Livesay and Pollard in 1943 demonstrated by various agglutination and complement fixation tests as well as by clinical picture that this disease was not Rocky Mountain Spotted Fever or Q Fever. In 1946, Pollard, Livesay, Wilson and Woodland not only produced the disease but also propagated the agent in yolk sac which produced typical disease after twenty serial transfers to yolk sac. These same workers isolated the agent from tick emulsions and grew it on yolk sacs reproducing the disease in human volunteers after twelve serial transfers. In the same year also these workers together and separately by challenging recovered cases of Bullis Fever with Dengue virus and Colorado Tick Fever agent showed no protection for either existed.

Control of Bullis Fever would appear to fall into the following categories:

1. Avoidance of contact.
2. Destruction of Ticks.
3. Destruction of hosts.

Removal of personnel from the Camp Bullis Area can be accomplished during peace time but in the event of mobilization and extensive field training this area is deemed essential and therefore the method is not practical as an ultimate solution. Removal of ticks from personnel is of considerable value but is not possible under all situations.

The Department of Agriculture, in cooperation with the Armed Forces, has been engaged in the screening and development of tick toxicants and repellents. Results are promising but are not as yet ready for publication. It is believed that the various pthallates offer considerable protection when used as was found effective in the



Southwest Pacific Area during the past war in Scrub Typhus control. Obviously the wearing of clothing such as high boots with tucked-in trouser legs offers considerable protection as does sleeping in hammocks off the ground. One of us (Morhouse) who has hunted in the Bullis area and in other sections of Texas where ticks are abundant has found that the Sulfur-foam applicator which has been used for the treatment of scabies is very effective in prevention of tick bites. The preparation is moistened in water, rubbed over the body and allowed to dry. On return to quarters, sulfur-foam is washed off. This method too would not be practical for large numbers of men on maneuvers over an extended period of time.

The destruction of ticks can be accomplished with DDT when mixed with pyrophyllite and spread in a concentration of 4 lbs per acre (roughly  $1\frac{3}{4}$  Kilos to 4000 square meters). Selected areas such as bivouac areas can be so treated. Dust appears to be preferable to residual sprays. A suggestion that beef cattle grazed over Camp Bullis and periodically dipped offers a rather unique method of tick destruction and might be worthy of trial.

Host destruction is not possible of accomplishment until the host is found. Deer are suspected of carrying the infectious agent at Camp Bullis. Kuhns carried out serological examinations, compliment fixation, and animal inoculations on rickettsial diseases from blood of deer shot during the previous hunting season with negative results. Further studies on tick control, repellent clothing, and host determinations are underway at the present time.

In conclusion, we feel that Bullis Fever is a clinical entity; that it is caused by a yet unclassified rickettsia; that the Lone Star Tick (*Amblyomma americanum*) is the vector and that the host is probably a wild mammal. It is of some interest to note that one case of possible Bullis Fever treated at Station Hospital, Randolph Field, Texas, with PABA responded within 48 hours and made complete recovery. This patient's serology was negative to OX-19, OX-K and OX-2. Patient had been fishing on the San Marcos River some 25 miles east of Camp Bullis and had numerous tick bites. His clinical picture was that of Bullis Fever. Three additional cases observed at Brooke Army Medical Center apparently responded to this drug also.

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## IRIDOMYRMECIN, AN ANTIBIOTIC SUBSTANCE EXTRACTED FROM THE ARGENTINE ANT (*Iridomyrmex pruinosus* *humilis* Mayr)

By *Mario Pavan*

During my researches conducted in 1947—48, partly with the help of my colleague Dr. Attilio Nascimbene, on antibiotic substances of animal origin, I also took into consideration various species of ants, and amongst these the Argentine ant, *Iridomyrmex pruinosus humilis* Mayr.

I chose this species because analysis repeated many times had shown me that it does not produce formic acid so that any antibiotic action which might be obtained from the extracts would have aroused greater interest.

In fact experiments performed on groups of workers have shown that it is possible to extract from the body of this species, with a number of solvents, amongst which may be mentioned ethyl alcohol, ethyl ether, acetone, chloroform, etc., an antibacterial substance to which I have given the name "iridomirmecina" (iridomyrmecin).

The most active extract has been found to be that obtained with ethyl ether, whereas the aqueous extract has no effect, or very little effect, on certain species of bacteria.

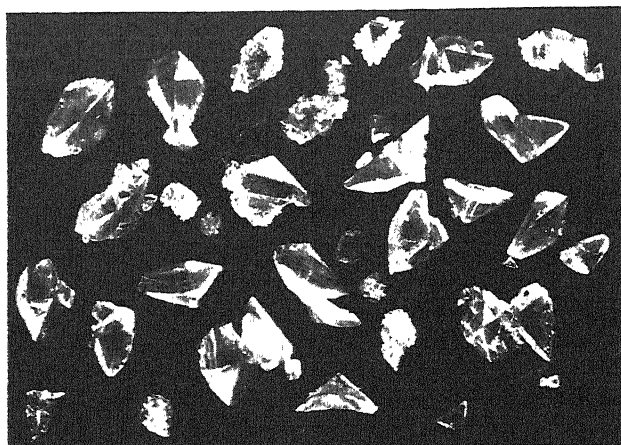
Research *in vitro* has been conducted with the agar-cup method, the most common in antibiotic research.

I show below a list of the species of bacteria on which experiments have been performed and which have all proved to be sensible in different degrees to the action of the antibiotic of Argentine ant: *Vibrio comma* (Schroeter) Bergey, *Staphylococcus aureus* Ros. (strain Oxford), *Bacillus anthracis* Cohn em. Koch *Brucella melitensis* (Hughes) Meyer and Shaw, *Br. abortus* (Schmidt and Weis) Meyer and Shaw, *Br. suis* Huddl., *Escherichia coli* (Mig.) Cast. and Chalm., *Proteus vulgaris* Haus, *Salmonella paratyphi* B (Kayser) Bergey, *Eberthella typhosa* (Zopf) Weldin, *Mycobacterium phlei* Lehm. and Neum., *Mycobacterium avium* Chester, *Shigella paradysenteriae* (Collins) Weldin, *Micrococcus lisodeikticus* Fl.

It is interesting to note that amongst these species there are a number of germs that are not sensible to the action of the common antibiotics of vegetable origin: amongst these I may mention *Vibrio*, *Brucella*, *Escherichia*, *Salmonella*, *Eberthella*, *Shigella*, and especially the bacillus of the tuberculosis of birds (*Mycobacterium avium*).

Research carried out the chemical and physical properties of the antibacterial substance contained in Argentine ant, has shown that the active part remains in the residue which may be obtained from the extracts produced with the above mentioned solvents, and that it does not pass from the chloroform extract in water twice distilled, alkaline water or acidified water.

Experiments performed on white mice (*Mus musculus albinus*) have shown that an animal weighing 25 gms can undergo without showing any reaction three subcutaneous injections on each alternate day of 0.04 cc. of oily residue obtained from the cold ethereal extract, diluted in sterilized almond oil. A white mice weighing 25 gms is however killed by a subcutaneous injection of 0.25 cc. of the same oily residue dissolved in almond oil.



*Crystals of iridomyrmecin ( $\times 7,5$ ).*

These experiments have shown that crude extracts possess a certain degree of toxic effect, but in the next phase of research, using a special procedure, I was able to obtain a notable degree of purity, and thus was enabled to crystallize the active part eliminating a high percentage of the crude extract. The crystallized part (according to the first results that I have obtained) represents at least 5% of the crude extract, and would appear to be present in the proportion of 1,5 gamma in each worker of the Argentine ant. These figures however are as yet provisional and subject to greater precision in relation to improvements in the technique of the production and purification of iridomyrmecin.

The crystallized product has so far been subjected to some experiments from which it has resulted that its activity remains unaltered for months at room temperature, both in the crystalline form and in solution.

Its melting point is at about  $58-59^{\circ}\text{C}$ . It is insoluble in water. It retains its antibiotic properties even if maintained for half an hour at  $120^{\circ}\text{C}$ , for a number of hours at  $-15^{\circ}\text{C}$ , for 90 days at  $37^{\circ}\text{C}$ .

The experiments on white mice were repeated using the crystallized product. From these experiments it has been shown that the toxic effect of the crude extract has been so reduced that the white mice can support without any reaction a daily injection of iridomyrmecin in solution in oil corresponding to one thousandth of the body weight, for three consecutive days. The mice so treated were observed for a week without any abnormality being shown. For other products, as can be read in the current literature such properties suffice to define atoxicity of the substance considered.

The practical aspect of the matter having shown itself increasingly interesting, the problem of the action of iridomyrmecin *in vivo* presented itself, and while waiting to be able to dispose of a quantity of substance sufficient for this purpose some experiments have been performed which have shown that the presence of blood in the cultural medium of a strain of *Staphylococcus aureus* does not reduce the antibiotic properties of iridomyrmecin.

Contemporaneously with the above work I am conducting research which has as its aim a further purification of iridomyrmecin and the discovery of its physical and

chemical characteristics. I do not however forget to conduct also a for reaching series of experiments of a naturalistic character with the aim of discovering the function of iridomyrmecin in the individual and social biology of Argentine ant.

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## SUMMARY OF ORIGINAL RESEARCH ON ANTIBIOTIC SUBSTANCES OF INSECTS

By Mario Pavan

A wide search for antibiotic substances which might be obtained from animal organism had not yet been made even though for many years very important facts have been known in this connection; these however have not been followed up. I may mention for example the work of Metalnikov and his collaborators (from the beginning of the century onwards) especially on the relationship between the larva of *Galleria mellonella* and Koch's bacillus, then the work of Duncan (1926) on some species of arthropods; that of Simmons in 1935 on the larvae of *Lucilia sericata*, and finally Oliviers's notes (1947) again on *Galleria mellonella*, followed by various authors on the same subject, and by Rehm in 1948 on the larvae of various species of insects.

A part from arthropods, few other facts are known except for some species of poisonous reptiles, blood serum, extracts from the brain of bullocks, extracts from placenta, from fats of the human epidermis, and the antibiotic action of various organic liquids.

The series of researches of which I give here a summary was begun in 1947 and was conducted in part with collaboration of Dr. Attilio Nascimbene. The problem considered was that of testing as great a number as possible of animal species belonging to the most divers zoological groups. In the course of these researches 48 different species have so far been studied of which 34 arthropods.

From 20 species of animals of which 18 arthropods, I obtained extracts having action on various germs. Limiting my results to the species of arthropods I shall immediately mention that I have partly been able to confirm that the antibiotic action was due to products which because of their toxic effects have little value from a practical point of view (for example formic acid present in extracts obtained from some Ants), whereas in other cases the antibiotic action is due to substances presumably unknown, which lead to a further study of the subject, because of its importance in naturalistic studies and not only because of any possible practical development.

The most interesting example is that of the antibiotic substance which I have obtained from the Argentine ant (*Iridomyrmex pruinosus humilis* Mayr) and which I have called *iridomyrmecin*. Work on iridomyrmecin has enabled me to crystallize the active substance, as I have explained in the relative notes in another part of this publication.

Other results which I consider interesting are those obtained from extract in ethyl alcohol, ethyl ether, chloroform, etc., of the heads of the Formicidae *Dendrolasius fuliginosus* and *Lasius bicornis affinis*. These extracts have a clearly defined antibiotic action *in vitro* on many bacteria amongst which are numerous species unaffected, or scarcely affected, by the more common antibiotics of vegetable origin (*Escherichia*, *Vibrio*, *Brucella*, *Shigella*, *Eberthella*, *Salmonella*, *Mycobacterium*, etc.).

So far I have been able to verify that the antibiotic action of these extracts remains unaltered for a number of months in normal conditions, and that the extract of *Dendrolasius fuliginosus* conserves its activity after being subjected for 20 minutes to a temperature of 120° C.

Research continues on the crude extracts in an attempt to concentrate the active part and to recognise its nature, in order to be able to perform experiments *in vivo*. At the same time I am conducting a series of experiments to discover the purpose of these substances in the biology of the ants which produce them. Other positive facts which are worthy of further research are those obtained by fixing in various solvents the volatile products of the explosive discharge of three species of *Brachynus*, and the antibiotic activity obtained with extracts from *Vespa*, *Apis* and *Notogonia*♀.

For some of these species and for other similar species facts can be found in the literature concerning the composition of the products of the explosive discharge and of the poisons, and it will therefore be interesting to re-examine these facts, considering their possible antibiotic activity.

The antibiotic activity of extracts from the poison glands of *Euscorpis carpathicus* and of *Trogloius*, *Schizophyllum* and *Callipus* also shown a certain interest because it makes one consider that the extension and intensification of these research might lead to interesting biological facts in a field as yet almost entirely unknown. All the experiments which I have conducted have been performed on bacterial cultures *in vitro* using the agar-cup method and only in the case of iridomyrmecin have experiments been made on the toxic effect *in vivo*, as explained in the note above mentioned.

#### First table

Crustacea	: <i>Androniscus dentiger calcivagus</i> Verh. (= <i>A. boldorii</i> Sthr.)
Myriopoda	: <i>Trogloius mirus</i> Manfr.; <i>Schizophyllum sabulosum</i> L.; <i>Callipus longobardius castanearum</i> Verh.
Scorpiones	: <i>Euscorpis carpathicus</i> (L.).
Lepidoptera	: <i>Sitotroga cerealella</i> Oliv (larva); <i>Cossus cossus</i> L. (larva); <i>Thaumetopoea pityocampa</i> Schiff. (larva).
Isoptera	: <i>Calotermes flavicollis</i> F.
Hemiptera	: <i>Pyrhocris apterus</i> L.
Coleoptera	: <i>Brachynus crepitans</i> L.; <i>B. plagiatus</i> Rej.; <i>B. sclopeta</i> Fabr.; <i>Chalenius nitidulus</i> Schr.; <i>Chl. vestitus</i> Payk; <i>Lytta vesicatoria</i> L.; <i>Meloe cica-tricosus</i> Leach; <i>Tenebrio molitor</i> L. (larve); <i>Blaps mucronata</i> Latr.; <i>Lamiinae</i> gen. sp. (larve); <i>Aromia moschata</i> L.; <i>Acanthoscelides obtectus</i> Say.
Diptera	: <i>Sarcophaga</i> sp. (larva).
Hymenoptera	: <i>Crematogaster scutellaris scutellaris</i> Oliv.; <i>Iridomyrmex pruinosus humilis</i> Mayr; <i>Formica rufa pratensis</i> Retz.; <i>Dendrolasius fuliginosus</i> Latr.; <i>Lasius niger</i> Latr.; <i>L. alienus</i> Foerst; <i>L. niger</i> × <i>alienus</i> ; <i>L. bicornis affinis</i> Sch.; <i>Vespa crabro caspica</i> Pérez; <i>Notogonia nigrita</i> Lep.♀; <i>Apis mellifica</i> L.

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## SECTION IX

## LA LUTTE CONTRE LES TAUPINS

Par L. Bonnemaison

Il existe en France quatre espèces principales de Taupins : *Agriotes lineatus* L., *A. obscurus* L., *A. sputator* F., *A. ustulatus* Schall., cette dernière étant cantonnée aux régions méridionales.

Les trois autres espèces sont en proportions sensiblement égales en Bretagne<sup>1</sup>. Dans la région parisienne, *A. sputator* est plus fréquent qu'*A. lineatus* et *A. obscurus*.

L'importance économique des Taupins s'est brusquement accrue depuis quelques années; en de nombreux endroits, ces insectes ont anéanti des semis de Betteraves et de Céréales (principalement de printemps) et fortement dépréciés les tubercules de Pommes de terre.

*Facteurs de pullulation. —*

Les facteurs climatiques n'exercent pas une action prépondérante sur la pullulation des Taupins : des dégâts notables ont été observés aussi bien dans les régions où les précipitations sont fréquentes (Bretagne) que dans le centre ou l'est de la France mais leur répartition est différente. Dans les contrées à climat maritime, les larves sont régulièrement distribuées dans tout le champ; sous les climats continentaux, les larves sont beaucoup plus nombreuses dans les zones humides (dépressions, sous-sol imperméable) que dans les terrains secs; cela tient à ce que les oeufs et les jeunes larves sont très sensibles à la sécheresse. C'est pour la même raison que les larves sont très nombreuses après une prairie, une culture de Trèfle ou de Luzerne; l'abondant feuillage de ces plantes maintient le sol meuble et humide en surface<sup>2</sup>. Les adultes se rassemblent en grand nombre sur ces plantes, déposent sans difficulté leur ponte dans le sol et les jeunes larves se développent dans les meilleures conditions.

D'une manière générale, les plantes ne souffrent des attaques des Taupins que de la fin-février à mi-mai et du début de septembre aux premiers froids; entre ces deux périodes, les larves fuient la terre superficielle sèche et chaude et pénètrent en profondeur dans le sol jusqu'à ce qu'elles atteignent une zone suffisamment fraîche.

*Méthodes de lutte*

Les méthodes de lutte à préconiser contre les Taupins peuvent être divisées en trois catégories : biologiques, culturales et chimiques.

a) *Méthodes biologiques —*

Les adultes et les larves sont détruits en petit nombre par quelques oiseaux et mammifères, des champignons : *Metarrhizum anisopliae* Metchn., *Entomophthora carpentieri* Gir, *Isaria* sp.; les larves sont rarement parasitées par deux hyménoptères : *Phaenoserphus pallipes* Lat. et *Paraxodrus apterogynus* Hal.

<sup>1</sup> d'Aguiar (J.) et Gison (P.) — 1948 — Premières études sur le problème des Taupins en Bretagne (C. R. Ac. Agricult. p. 261).

<sup>2</sup> L. Bonnemaison — 1948 — Les Taupins : biologie et méthode de lutte. (Agriculture, no. 94 et 95. pp 287. 291 et 321. 325.)

Dans les cultures de faible étendue, on peut capturer des larves en plaçant à 3 ou 4 cms de profondeur des tranches de Pomme de terre ou de Betterave que l'on examine tous les deux jours.

Les adultes sont attirés par des bottillons de Trèfle, de Luzerne, de Haricot ou de Graminées que l'on dispose sur le sol; les Taupins se rassemblent sur ces bottillons et il est facile de les ramasser par le secouage au-dessus d'une toile.

Ces expériences ont généralement été faites sur des cultures de plantes faiblement attractives pour les adultes : céréales, plantes sarclées diverses; nos essais ont été faits dans une luzernière afin de voir si ces bottillons attireraient les insectes malgré la proximité immédiate d'une plante particulièrement recherchée. Dans ce but, la Luzerne était fauchée de place en place sur une surface d'environ 1 m<sup>2</sup> et le bottillon était disposé au centre; il a été essayé comparativement de la Luzerne et des graminées (principalement ray-grass et dactyle). Des bottillons frais étaient apportés tous les cinq jours. Le maximum de captures pour les graminées comme pour la Luzerne a généralement été enregistré trois à cinq jours après la mise en place des pièges. Peu de temps après la sortie des insectes, les graminées ont été cinq fois plus attractives que la Luzerne; ces différences se sont ensuite atténuées (Fig. 1).

Le nombre total des captures a été très important le 22 avril (Fig. 2); il est ensuite resté sensiblement constant jusqu'au moment de la fauchaison de la Luzerne (19 mai);

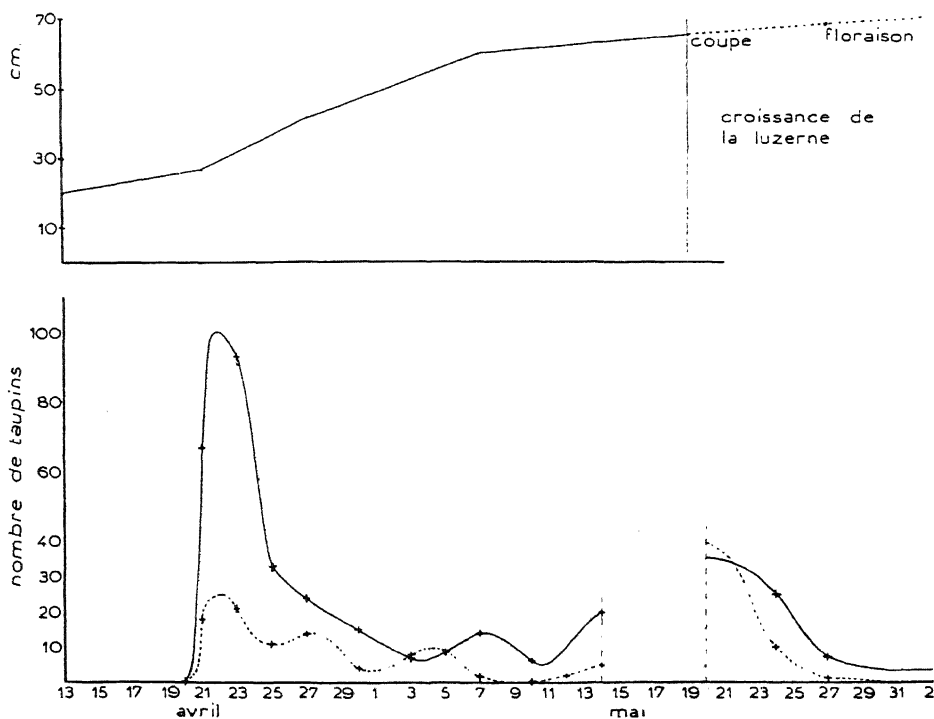


Fig. 1. Captures des adultes d'*A. sputator*, *A. lineatus* et *A. obscurus* sur 10 bottillons de Luzerne (en pointillé) et de graminées (en trait plein) répartis dans une champ de Luzerne.

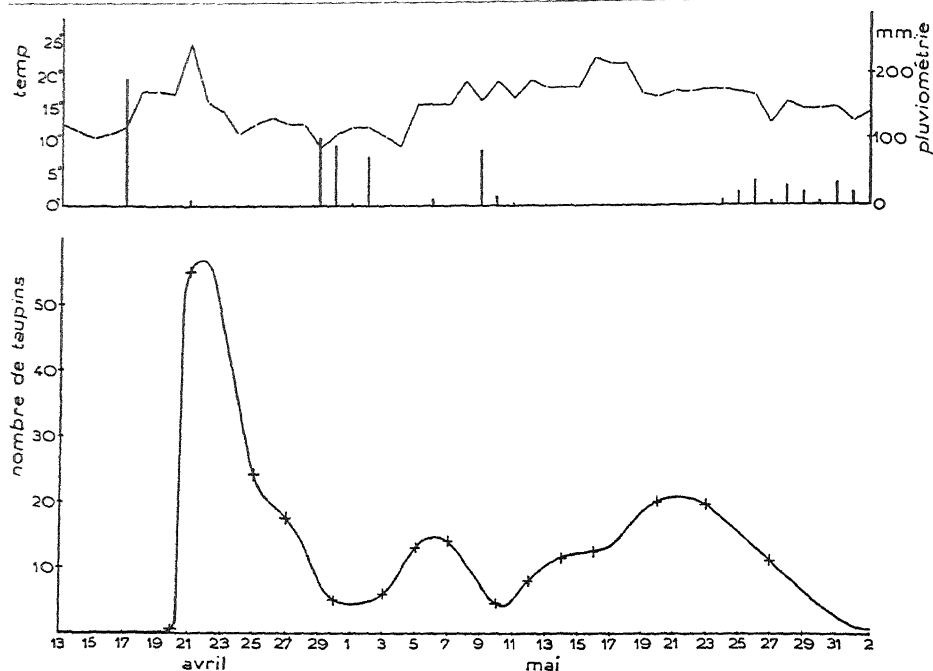


Fig. 2. Captures moyennes des adultes d'*A. sputator*, *A. lineatus* et *A. obscurus* sur l'ensemble de la Luzernière rapportées à 5 bottillons de Luzerne et 5 bottillons de graminées, pluviométrie et température moyenne à 5 cm au-dessus du sol. (gazon).

les captures ont été nettement plus faibles par temps pluvieux que par temps sec. Les bottillons de Luzerne se dessèchent plus rapidement que ceux de Graminées; ce fait explique pour une part les variations d'attractivité constatées entre ces plantes; au début de l'expérience, la Luzerne sur pied était de petite taille et la température élevée; par la suite, l'accroissement de la Luzerne a protégé les bottillons de l'insolation.

#### b) Méthodes culturales —

Les méthodes culturales ont pour but de placer brusquement les oeufs et les larves dans un milieu relativement sec, ce qui provoque rapidement leur mort, ou de faciliter la croissance de la plante afin de lui permettre de subir sans trop de dommages l'attaque de ces insectes.

La ponte débutant généralement dans les premiers jours de juin, la destruction des oeufs et des jeunes larves pourra être obtenue par des façons superficielles effectuées depuis le début de juin jusqu'à la fin du mois d'août; malheureusement, à cette période de l'année, la plupart des plantes cultivées recouvrent presque complètement le sol et ces travaux sont donc d'une réalisation difficile. Leur efficacité est beaucoup plus faible lorsqu'ils sont effectués au printemps ou à l'automne par suite de la forte humidité de l'air et du sol ainsi que de la température basse qui caractérisent généralement ces saisons; en outre, elles ne peuvent atteindre que des larves plus âgées qui sont généralement capables de s'enfouir rapidement dans le sol. Cependant, des façons superficielles fréquentes effectuées si possible par temps sec, en obligeant les larves à s'enfoncer dans le sol à plusieurs reprises, provoquent la mort d'un certain nombre

d'entre elles : il est donc des plus recommandables de faire des cultures sarclées dans les terres présentant une forte population de larves de Taupins. Les légumineuses fourragères créent un milieu des plus favorables à la ponte et au développement des jeunes larves; dans les régions fortement infestées, la culture de la Luzerne et du Trèfle est donc à limiter au strict minimum.

Les larves de Taupins étant plus abondantes dans les terrains ou zones humides, le drainage permettra, dans certains cas, de réduire considérablement l'importance des dégâts.

L'emploi de céréales d'automne de préférence aux céréales de printemps, un semis un peu dru effectué précocement pour les céréales de printemps, l'emploi de variétés tallant fortement, permettent d'obtenir une récolte satisfaisante même dans les terres hautement infestées. Les pommes de terre arrachées précocement sont beaucoup moins attaquées que celles récoltées à la fin de la saison.

### c) Méthodes de lutte chimiques

1°) *Lutte contre les larves.* Il a été recommandé jusqu'à ces toutes dernières années d'incorporer au sol des matières alcalines, de la sylvinite, du chlorure de potassium, du superphosphate, du nitrate de soude; aucune de ces substances, sauf le superphosphate employé dans des conditions très particulières, n'a donné des résultats satisfaisants.

La chloropicrine, la naphthaline, le paradichlorobenzène, l'isothiocyanate d'allyle, le dichlorure d'éthylène, le bromure de méthyle, le dibromure d'éthylène, sont onéreux ou d'une utilisation trop délicate pour pouvoir être retenus.

Nous avons procédé à des essais comparatif en deux endroits bien différents par la nature du sol et la pluviométrie: l'Île de France et la Bretagne (environs de Morlaix).

Un premier essai a été réalisé le 10 avril 1946 sur de l'Avoine de printemps haute de 6 à 8 cms, fortement attaquée par les larves de Taupins. Les traitements ont été faits par arrosage ainsi que par l'épandage entre les lignes de poudre insecticide mélangée à la couche superficielle du sol par un léger binage<sup>3</sup>.

Pour cet essai comme pour ceux qui sont mentionnés plus loin, l'estimation des résultats a été faite par la numération des plantes sur 60 à 180 lots de 1 mètre pris au hasard pour chaque insecticide utilisé; les chiffres obtenus ont été calculés par rapport au lot témoin.

Tableau n° 1 — *Influence de divers insecticides employés en arrosage et poudrage sur de l'Avoine de printemps*

Produits essayés	Dilution ‰	Quantité à l'ha	Nombre de plantes
Témoin			100
Dichloroéthyléther pur	0,2	30.000 l.	222
Emulsion de dichlorodiphényltrichloroéthane à 10 ‰ de matière active	2,0	30.000 l.	286
Hexachlorocyclohexane technique à 10 ‰ de M. A.	2,0	30.000 l.	416
Hexachlorocyclohexane technique à 8 ‰ de M. A.		250 kg.	263

Le dichloroéthyléther, très utilisé aux Etats-Unis, s'est révélé dans nos essais très inférieur à l'Hexachlorocyclohexane.

Les traitements par arrosages nécessitent une trop grande quantité d'eau pour que l'on puisse envisager leur emploi en grande culture; ils ne présentent de l'intérêt que

<sup>1</sup> Bonnemaison (L.) 1947 — Essais préliminaires de traitements contre les Taupins (C. R. Ac. Agric., p. 556).

pour la protection d'arbustes, de plantes vivaces ou encore de plantes ayant une certaine valeur économique.

Un coefficient d'efficacité de 90,5 % a été obtenu sur le Tabac<sup>2</sup> avec une émulsion renfermant 20 % de D.D.T. employé à la dose de 0,5 % : il est versé 250 cc. de l'insecticide par pied au moment du repiquage.

Des essais ont été faits au printemps de l'année 1948 en Bretagne et dans la région parisienne sur des terres qui ont été ensemencées par la suite en céréales de printemps. Les poudres ont été épandues à la main et mélangées à la couche superficielle du sol par deux hersages; les arrosages ont été faits à raison de 200 hl. à l'ha.

En Bretagne, le traitement a été fait le 10 février et le semis 18 jours plus tard; dans la région parisienne, l'épandage a eu lieu le 9 mars et le semis le 30 mars.

Tableau n° 2 — *Influence de divers insecticides employés en poudrages, en arrosages et en injection avant le semis de céréales de printemps*

Témoin		100		100
<i>Poudrages avec produits renfermant :</i>				
— 8 % d'hexachlorocyclohexane à 15 % d'isomère $\gamma$	10 kg	267	10 kg	188
— do.			20	201
— 3,5 % d'Hexachlorocyclohexane à 13 % d'isomère $\gamma$	9	248	9	184
— 45 % de dérivé sulfuré de l'Hexachlorocyclohexane			45	202
— 1 % de Thiophosphate de diéthyle et de paranitrophényle	2,5	231	2,5	180
— 1 % do.			5,0	197
— 25 % de cyanure de calcium	25	180		
<i>Arrosages avec produits renfermant :</i>				
— 12 % d'Hexachlorocyclohexane dilué à 1 %			24	195
— 14 % du dérivé sulfuré de l'Hexachlorocyclohexane dilué à 0,7 %			20	147
— 20 % de Dichlorodiphényltrichloroéthane en émulsion dilué à 0,5 %			20 l.	140
— 20 % de Thiophosphate de diéthyle et de paranitrophényle dilué à 0,075 %			3 l.	193
<i>Injection dans le sol avec produits renfermant :</i>				
— 100 % de Dichloropropane-dichloropropylène	400 l.	138		
— 66 % de sulfure de carbone	265 l.	144		

L'examen comparatif de ces chiffres montre que les résultats ont été nettement plus satisfaisants dans l'Île-de-France qu'en Bretagne; cela est simplement dû à ce que le semis a été fait en Bretagne à une dose supérieure à la normale; les larves se sont dispersées sur un plus grand nombre de pieds et la mortalité des céréales a été en conséquence moins élevée dans ce dernier cas.

Il y avait 150 à 180 larves par m<sup>2</sup> dans le champ de l'Île de France et de 190 à 250 en Bretagne.

Les produits donnant les résultats les plus intéressants sont donc les poudres à base d'hexachlorocyclohexane titrant 13 à 15 % d'isomère  $\gamma$  et utilisées à la dose de 10 à 12 kgs d'H.C.H. technique à l'ha et le thiophosphate de diéthyle et de paranitrophényle à la dose de 5 à 6 kgs de produit pur à l'ha.

<sup>2</sup> Gisquet (P.) et Quidet (P.) 1948 — Emploi des insecticides de synthèse contre les parasites du tabac. C. R. Ac. Agr., p. 134).

L'H.C.H. employé à la dose de 20 kgs et même 10 kgs à l'ha entraîne des troubles de croissance chez certains végétaux : céréales (sauf l'orge) (Fig. 2), Betteraves, Pommes de terre; il est donc prudent de l'appliquer trois à quatre semaines avant le semis; par contre, il active la végétation de la Luzerne et d'une manière plus générale, semble-t-il, celle des Légumineuses; il serait intéressant d'étudier son influence sur les microorganismes du sol.

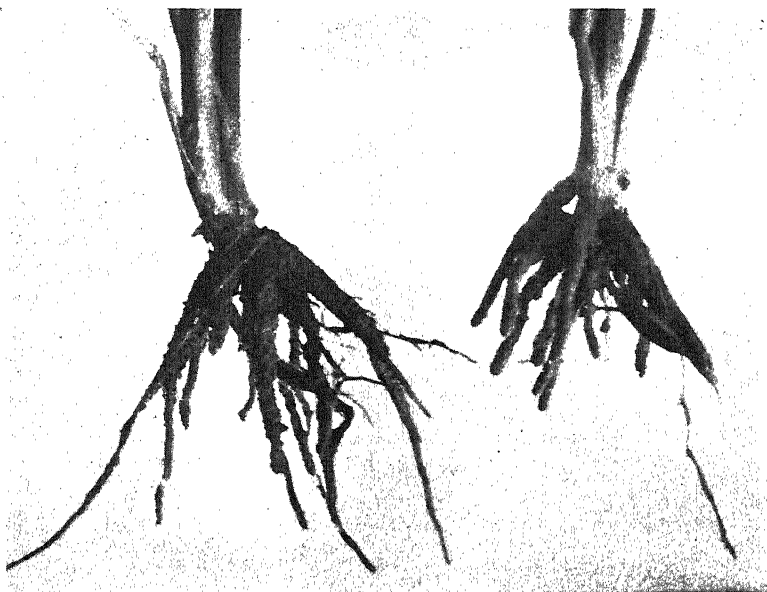


Fig. 3. Influence sur le système racinaire de l'Avoine (5 juin 1948) d'une poudre à base d'H. C. H. épanchée à la dose de 15 kg d'H.C.H. à l'ha 3 semaines avant le semis (à gauche témoin).

L'H.C.H. et ses dérivés sulfurés communiquent fréquemment un goût désagréable aux racines et aux tubercules; il est recommandable de ne cultiver ces plantes qu'au moins un ou deux ans après l'emploi de l'insecticide.

Le prix de revient de ces traitements est assez élevé.

Ces divers inconvénients nous ont incité à rechercher d'autres méthodes de lutte, dirigées non plus contre les larves mais contre les adultes.

2° *Lutte contre les adultes.* Nous avons disposé dans une jeune luzernière, des bottillons de Luzerne et de Graminées; des bottillons frais étaient apportés tous les cinq jours et il a été dénombré chaque jour ou tous les 2 jours les Taupins qui s'y trouvaient.

En 1948, les grosses sorties d'*A. lineatus* et *A. sputator* se sont produites après la pluie du 17 avril; *A. obscurus* a été observé seulement après les précipitations du 28 avril au 2 mai dans une prairie où *Dactylis glomerata* était particulièrement abondant et n'a été trouvé dans la luzernière que le 10 mai; le nombre des individus capturés sur les bottillons de Luzerne ou de graminées a progressivement augmenté, et à partir du 20 mai, cette espèce devenait la plus commune des trois.

Les adultes sont particulièrement abondants dans les champs de Luzerne et de Trèfle. D'une manière très générale, les dégâts des Taupins ne sont appréciables que dans les cultures qui succèdent à ces plantes; la destruction des adultes devait donc être effectuée dans les champs de Luzerne et de Trèfle et quelques jours avant le début de la ponte. Celle-ci a généralement lieu à la fin du mois de mai et au début de juin, c'est-à-dire une semaine avant la date habituelle du fauchage.

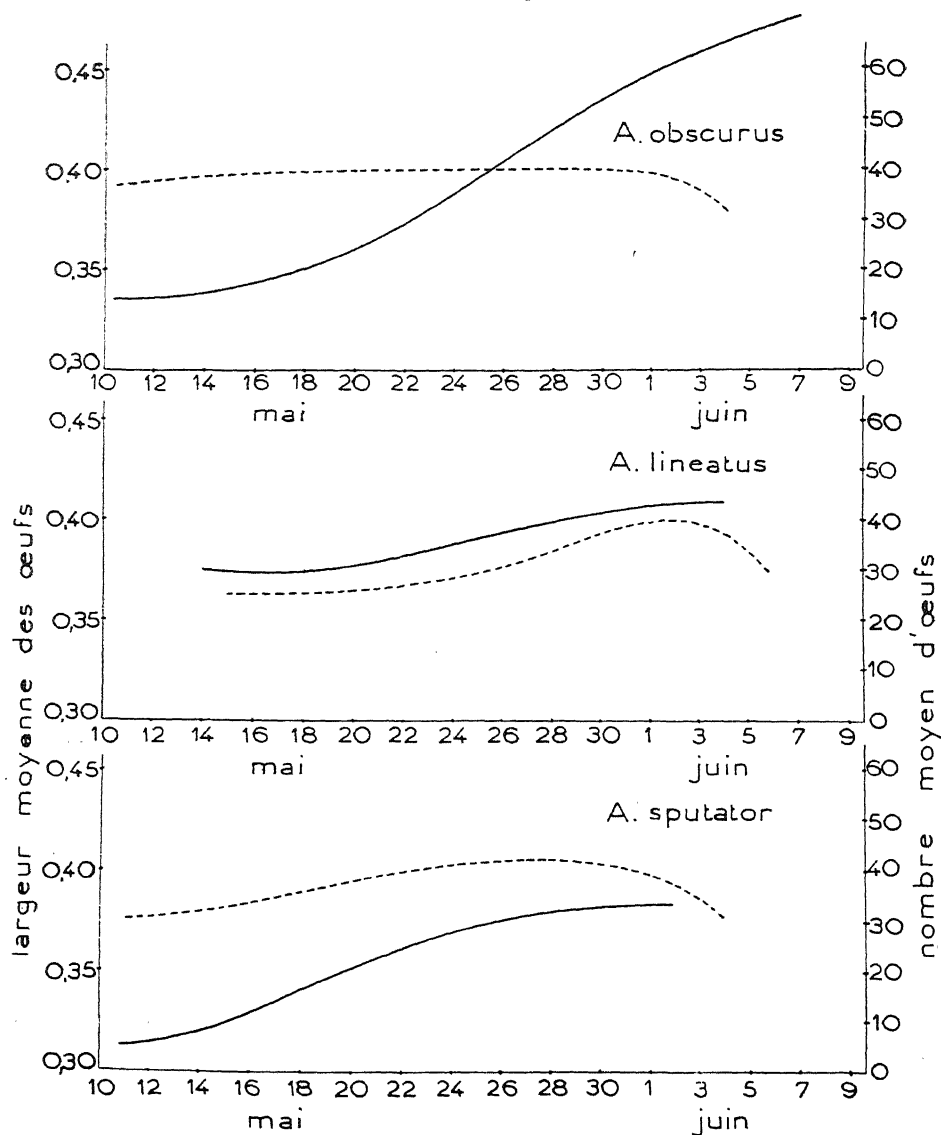


Fig. 4. Largeur moyenne des oeufs (en trait plein) et nombre d'oeufs (en pointillé) chez les femelles d'*A. obscurus*, *A. lineatus* et *A. sputator* du 10 mai au 5 juin 1948

On ne peut envisager de traiter les plantes sur pied car l'abondance du feuillage ne permettrait pas à l'insecticide d'atteindre les Taupins et par ailleurs le fourrage serait imprégné de substances pouvant être toxiques pour le bétail.

Le traitement sera donc effectué après la coupe et l'enlèvement de la récolte, ce qui conduit à envisager le premier fauchage vers la mi-mai.

Il était important de pouvoir connaître un certain temps à l'avance la date probable de la ponte; dans ce but, nous avons disséqué des femelles d'*Agriotes sputator*, *A. lineatus* et *A. obscurus* à intervalles réguliers. Le 26 avril, les femelles d'*Agriotes obscurus* ont une trentaine d'oeufs bien développés mesurant 0 mm. 66 de long et 0 mm. 30 de large; ceux de *A. lineatus* sont moins nombreux mais ont à peu près les mêmes dimensions. La fig. 4 indique le nombre moyen d'oeufs trouvé dans les ovarioles des femelles des trois espèces ainsi que leur largeur moyenne pour la période s'étendant du 20 mai au 12 juin 1948; pour les trois espèces, la ponte a débuté entre le 28 mai et le 2 juin et la majorité des oeufs étaient déposés dans le sol à la date du 5 juin.

Nous avons vu précédemment que les bottillons de Luzerne et de graminées attirent un nombre important d'adultes; il était donc possible d'envisager la destruction de ces insectes en traitant des bottillons distants de 5 à 6 mètres et répartis dans un champ de Luzerne ou de Trèfle après la coupe, ou de toute culture (Pomme de terre, Betterave par exemple), avec un insecticide qui s'était montré efficace en essais de laboratoire<sup>5</sup>.

Les traitements ont été faits par poudrages avec des produits commerciaux à base de D.D.T., H.C.H. et de thiophosphate de diéthyle et de paranitrophényle dans un champ de Luzerne fauché 48h. auparavant et dont la récolte avait été enlevée. Les résultats ont été médiocres.

Une autre méthode a été utilisée; il a été fait un poudrage du champ après le fauchage et l'enlèvement de la Luzerne; la plante présente à ce moment un très petit nombre de folioles et il est possible de traiter 1 ha avec 15 à 20 kgs de poudre seulement.

Les Taupins effectuent des déplacements importants dès que la récolte est enlevée, et dans les cas où les parcelles sont étroites, abandonnent le champ traité pour se porter sur les cultures voisines. Cette méthode convient donc plus spécialement aux cultures fourragères de grande étendue.

Un premier essai a été fait cette année mais son efficacité ne pourra être pleinement estimée que dans 3 ans; quoiqu'il en soit, cette méthode de lutte présente plusieurs avantages sur le traitement du sol; elle nécessite cinq à six fois moins d'insecticide, n'exige pas de façons culturales supplémentaires et ne peut nuire à la croissance des plantes ni aux micro-organismes du sol. Enfin, elle permet de détruire par la même occasion un grand nombre d'insectes phyllophages (Otiorrhynques, Phytonomes, Négril, Apions, etc. . .) qui diminuent parfois la récolte de façon appréciable.

<sup>5</sup> Bonnemaison (L.) — 1948 — Sur une nouvelle méthode de lutte chimique à appliquer contre les Taupins (C. R. Ac. Agric., p. 174).



## A BIOASSAY TECHNIQUE USING *CALANDRA GRANARIA* FOR THE DETERMINATION OF THE PERCENTAGE OF PURE INSECTICIDE IN A CRUDE PREPARATION

By *H. H. S. Bovingdon*

### *Introduction*

In the early development of dichloro diphenyl trichlorethane (DDT) and benzene hexachloride (BHC) it was known that the total amount of chlorinated organic chemical in a crude preparation or a formulated dust could be chemically determined from the hydrolysable chlorine. No differentiation could be made, however, between insecticidal and non-insecticidal isomeric organic molecules. Thus, the need arose to measure the quantity of active isomer in a crude product, for example, the *pp'* isomer of DDT, which was present to some 50 %—80 %, or the gamma isomer of BHC, which was present only to some 13 %.

We had been working for some years with grain dusts and had a method for comparing the efficiencies of inert dusts used in the control of grain pests, especially *Calandra* spp. The test was carried out very simply with *C. granaria*, the grain weevil, on dusted grain. Kills were measured at appropriate times and fell in the range of 10—95 %. Replicate experiments were made with each dust and the results expressed in the form of toxicity indices which were treated by an analysis of variance to determine significant differences. Later, however, toxicity indices were abandoned in favour of a better technique whereby the concentrations for 50 % kill at constant time were compared.

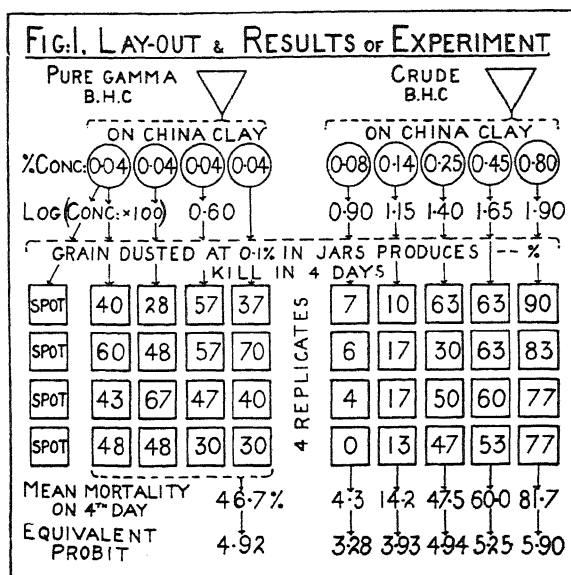
With some little modification the grain dust technique was adapted for the determination of the active isomers in crude DDT and BHC but the main principles were retained. A graphical relation was obtained between toxicity and concentration of the crude material over a suitable concentration range from which the concentration giving the same kill as that of a standard, based on the pure isomer, was secured. Suitable transformations were adopted to ensure that the relationship between the experimental data was approximately linear. Since the determination of the gamma isomer of BHC has been the main concern in our laboratories, the following sections will be confined to that compound.

### *The assay method*

Because "BHC gamma isomer" is so toxic to insects, the chemical is first diluted with China clay. Standard dusts based on "BHC gamma isomer" at .04 % are prepared in quadruplicate in two-ounce, screw-topped, glass bottles, by mixing or puddling the isomer and the China clay with ether to the consistency of a thin cream and subsequently drying in a stream of air at room temperature. The bottles are then closed with a paper-covered cork and turned for two hours on mechanical rollers to give a uniform mixture. Under the conditions of the test, such dusts, added to wheat at .1 % by weight, produce a 50 % mortality among *C. granaria* in about 4 days.

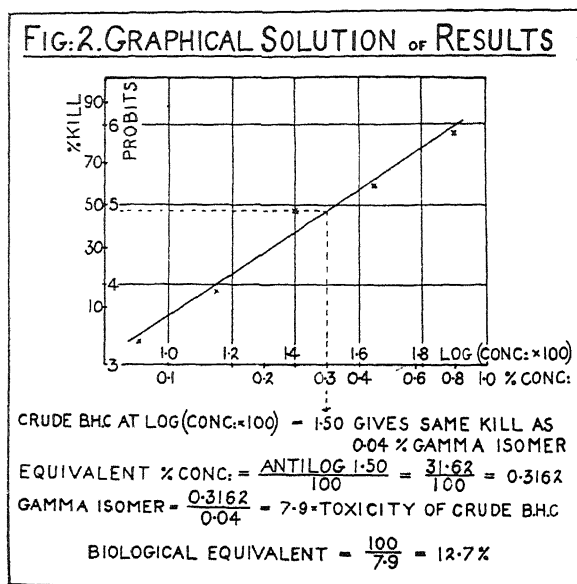
Dusts are similarly prepared from technical BHC or any formulated product containing an unknown amount of that material. Five dilutions, spaced logarithmically,

are used so as to give kills falling in the range of about 5—95 % in 4 or 5 days. For instance, when testing crude BHC containing about 13 % gamma isomer, the dilutions used are .08 %, .14 %, .25 %, .45 % and .80 %. The amount of dust added to the wheat is kept constant at .1 %, as with the standard. The total number of dusts involved in the test of one sample of crude BHC is, therefore, nine, four standards at .04 % "BHC gamma isomer" and five dusts based on the unknown material at different levels.



For the testing of one sample, thirty six two-ounce jars, allowing four replicates for each dust, are each filled with 30 gm. wheat having a moisture content of about 14 %. The appropriate dust is added and the jars lightly closed. They are then turned for two minutes on mechanical rollers and, finally, thirty insects added to each jar. The whole set of jars is stored at 25° C, and 70 % relative humidity, and counts made at suitable intervals. Experiments have shown that results are not significantly affected if the jars, instead of being closed with lids, are covered with gauze. It may be inferred, therefore, that the fumigant effect of "BHC gamma isomer" in this test is normally slight. In order not to disturb the jars before it is necessary, four extra jars of wheat, dusted with .04 % "BHC gamma isomer" are also included. These are called "spots". When the kills recorded for the "spots" reach 40—50 %, the remaining jars are examined and mortality counts made in random order. If the kills for the "spots" are much less than 50 %, counts are made on the following day, when the mortality is generally 15—25 % higher. The mortalities are determined by emptying the contents of each jar on to glazed paper, counting and throwing away the dead insects and returning the wheat, dust and live insects to the jar for a later count. An insect is considered dead if it makes no visible movement whatever when it is warmed for about 20 seconds.

To determine the percentage of "BHC gamma isomer" in question, a graphical relation is established by plotting probits as a measure of the percentage mortality, against the log of the concentration of the unknown sample in the .1 % dust, according to the method of Bliss<sup>1</sup>. The best-fitting line is drawn through the five points representing the average kill at each concentration, generally after its slope and position have been calculated. From the graph, the log concentration of the unknown sample, corresponding to the average probit given by the standard dust at the 4-day count, is read off. The corresponding antilog gives the concentration of the unknown sample which is matched by pure gamma isomer at .04 %. The percentage of gamma isomer in the unknown sample can therefore be readily calculated. If similar calculations are also made for a 5-day count, the two estimates are averaged.



### Discussion

The efficiency of the biological method of assay has been statistically analysed. Tests to determine the reproducibility of preparing and testing samples of "BHC gamma isomer" showed no significant difference between samples, between dusts from the same sample or between the work of the counters. The difference between preparers of the dusts reached the 10 % level of significance indicating possible variation at this stage of the work.

It has also been shown statistically that the best layout of dust test is that in which the number of standard dusts is approximately the same as the number prepared from the unknown sample. The coefficient of variation, obtained in repeated measurements of gamma isomer samples, was about  $\pm 10\%$ . For measurements of crude BHC, of 14.5 % gamma isomer content, it was slightly higher, at about  $\pm 12\%$ .

<sup>1</sup> Bliss, C. I., 1935: The Calculation of the Dosage-mortality Curve. Ann. App. Biol. 22(1) pp. 134-167.

In comparing two samples of crude BHC by a single determination on each, a difference of 5.6 % would indicate a significant difference between the biological figures at the 5 % level. To establish the significance of differences smaller than this, the biological determinations would need to be repeated and average results compared. Thus, by taking means of four determinations for both samples, a difference of 2.8 % between means would reach significance at the 5 % level.

Determinations of "BHC gamma isomer" in crude benzene hexachloride by bioassay were generally slightly higher than those from physical assay methods. It was inferred, therefore, that the biological assay measured something more than merely the "BHC gamma isomer" content of such a sample. For instance in an extended series of measurements on samples of crude BHC, figures of 13.2 % and 12.5 % were obtained for mean biological and polarographic determinations respectively. The results of later experiments supported these findings and it has been customary to describe the bioassay figures as the "biological equivalent" of the BHC preparation in terms of pure BHC gamma isomer.

Further work has shown that the level of the biological equivalent is affected in various ways. For instance, the mode of preparation of the dusts is important. The biological equivalents for dusts prepared from dry ingredients are always lower than those from dusts puddled with ether in the manner described, when the comparison is made with standard dusts also prepared by puddling. As an example, the biological equivalent of a sample of crude BHC, from which dusts were prepared by the puddling method was 14 % (coeff. of variation = 11.6 %). When dusts were prepared from the same material in the dry way, and compared with a standard made up by puddling, the biological equivalent was 7.7 % (coeff. of variation = 30.2 %). On the other hand when the standard was made up in the dry way, the biological equivalent is expected to be normal.

Again, the presence of other isomers in a BHC sample and the sequence in which they are precipitated from a given solvent may also effect the level of the biological equivalent. The equivalent of a preparation of 3 % BHC pure gamma isomer on China clay determined by the normal technique using ether as a solvent was 2.97 % (coeff. of variation 25 %). By a similar technique the equivalent for a mixture containing 3 % "BHC gamma isomer" and 97 % alpha isomer was found to be 5.4 % (coeff. of variation 9.8 %). Since the gamma isomer is more soluble than alpha isomer in ether, the alpha crystals, first deposited, may be more or less covered by a mixture of crystals richer in gamma isomer content so that the biological equivalent is increased. When a mixture of 3 % "BHC gamma isomer" and 97 % delta isomer was examined using methyl alcohol in place of ether, the biological equivalent was found to be 2.89 % (coeff. of variation = 3.7 %). The gamma isomer is less soluble than the delta isomer in methyl alcohol so that it might be expected that the biological activity of the gamma isomer would be reduced. No such reduction was observed and more knowledge of that system is necessary before the results can be correctly interpreted. The biological activity was certainly not increased. The results in this paragraph are given as means of three determinations.

Further, if the test is carried out in the normal way, in the absence of wheat, consistently lower results are obtained for which no satisfactory explanation has yet been found.

From the work which has been described, it will be noted that the biological method for determining the amount of "BHC gamma isomer" in a BHC preparation involves

a fair amount of labour and, as a consequence, one may prefer to employ chemical or physical assay methods. Nevertheless, if the mode of presentation of the toxic principle in a formulated product is important, as the above findings suggest, only a biological method of assessment will give an adequate measure of performance.

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## THE UTILIZATION OF *Bacillus popilliae*, Dutky, AGAINST *Popillia japonica* Newm.

By Ernest N. Cory and George S. Langford

The use of the bacterial diseases of the Japanese beetle in the control of the larval stage has been practiced in most of the states along the Atlantic Seaboard, and to a limited extent elsewhere in the United States. The results have been so good in Maryland that it is considered worthwhile to bring to your attention the methods used and the results achieved.

### *Historical:*

The beetle, *Popillia japonica*, was first discovered at Riverton, New Jersey, U.S.A. in 1916 by Dickerson and Weiss (4). The evidence pointed to its introduction on herbaceous perennials from Japan and it therefore was given the common name, the Japanese beetle.

*Popillia japonica* females deposit in turf approximately 50 eggs each. These hatch in about 14 days and usually pass through three instars before could weather drives them below the root level where they remain during the cold period. As the earth warms the grubs return to feed upon grass roots and have a pre-pupal stage of 8 to 20 days before pupation in early June. In ten days to two weeks the beetles begin to emerge from the ground reaching their peak of emergence in Maryland about July 15.

The beetle was first discovered in Maryland in 1927 (3) and attempts to eradicate it were made by using carbon bisulphide emulsion as a soil fumigant. The treatment was based on the supposition that grubs were present in the areas where the beetles were discovered. Later experience with the beetles indicated that the flight of the beetles was on such large radii that soil treatment in many instances was inadequate to cover the area of egg deposition.

In subsequent years, trapping, spraying and agronomic practices such as late planting of corn to avoid damage to the silks were used in an endeavor to retard the spread and mitigate the losses. Despite the collection, by traps, of as much as 275 tons of beetles in a single year (2) the beetles continued to spread, and since no insecticide was known that gave economically practicable control, it was decided to attempt biological control. Parasite colonization work was started in 1938 and supplemented in 1939 by the use of a bacillus that seemed to have distinct possibilities.

As early as 1921 workers of the Bureau of Entomology and Plant Quarantine found that the larvae of *Popillia japonica* were subject to a number of undescribed diseases. In 1935 Hawley and White (8) called attention to a group of diseases that caused an unnatural milky coloration of larvae. In 1940 Dutky (5) described two spore forming bacteria which gave the blood of the larvae a milky coloration. These he designated as *Bacillus popilliae* and *Bacillus lentimorbus*. He named the disease produced by the first organism type A milky disease and that produced by the second organism type B milky disease.

These diseases were designated milky diseases since the presence of vast numbers of the organism in the body of the grub renders the grub opaque, obscures the dorsal blood vessel and turns the insect blood to a milky color and consistency.

Both strains of milky disease occur in Maryland, but the production and distribution has been confined principally to the type A disease. Type B which occurs in limited areas has been propagated and distributed on an experimental basis.

Many of the biological aspects of the disease such as the susceptibility of the larval instars to the disease, the number of bacterial spores produced and the pathological effects of the organism on the host have been reported upon by Beard (1).

#### *Production of Disease:*

Grubs in the third instar are collected and kept in cold storage in soil at 45° F. until they are to be inoculated. Cold storage is essential to prevent grubs from nipping each other thereby causing the loss of usable grubs. Each grub is given a shot into the dorsal segments with a hypodermic needle loaded with a standardized suspension of spores. Each grub gets approximately 2 million spores in about one seventh of a drop of distilled water. This injection is made under a binocular microscope with a special micro-syringe actuated by a screw governed by an escapement that regulates the number of turns of the screw. It is remarkable that each worker soon learns to inject about 1,500 grubs per day with little injury to the grubs, and achieves a final efficiency up to 70 per cent.

After injection each grub is placed in an inch-square compartment in the incubating boxes in soil in which red top and clover seed<sup>1</sup> are mixed. The boxes are of wood with four solid horizontal plates of zinc and vertical 1 inch strips of zinc interlocked to make the separate cubical chambers. Each box contains 500 grubs. The boxes are then placed in an incubating room held at a temperature of 85° and a high moisture content. The seed germinates, furnishing food for the grubs, and in ten to twelve days the 2 million spores have multiplied to between 2 and 5 billion spores per grub. The majority of the grubs remain alive, however, and at the expiration of the incubation period they are removed and those showing milky disease are stored in ice water until a sufficient quantity has been accumulated for the next step. This step is the grinding of the grubs with the adhering water into a concentrated suspension of spores. Counts in a Levy chamber determine the number of spores per cubic centimeter, and this material is then mixed with precipitated chalk into a dust of known spore concentration per gram and then combined with talc for bulk. Spores for use in preparing inoculum are maintained on glass slides in dried blood films. The blood films are prepared by bleeding heavily infected grubs on the clean and sterilized glass slides. Spores remain viable for long periods when held in this form.

#### *Method of Utilization:*

The original plan of distributing the disease spores in Maryland was to treat three acres of grub infested sod in each square mile of the heavily infested areas. This was supplemented as material became available so that in the older infested areas each farm and many of the lots in urban areas were finally treated with the milky disease. As the Japanese beetle invaded more counties of Maryland the treatment progressed in each new locality on the original basis. As the beetle became more numerous in each locality the same effort has been made to increase the area of distribution until each farm has been inoculated. The distribution is made at the rate of 2 pounds of dust carrying approximately 75 billion spores per acre.

<sup>1</sup> *Agrostis alba* and *Trifolium* sp. Both *Trifolium repens* and *T. pratense* have been used.

Distribution in urban areas has complicated the work somewhat due to the large number of properties involved as compared with the farming areas. The results have been so good that each property holder wants his place treated. It has been difficult to satisfy everyone, but constant repetition of the story of the ways in which the disease may be spread has helped to maintain popular support for the program.

It was demonstrated by Langford et al (9) that the adult may harbor, develop and distribute the disease upon its death and disintegration. Adults may also disseminate the disease during the process of egg laying by burrowing into soil already inoculated and then later reentering the soil at another point. Birds may also spread the disease by eating diseased grubs and distributing viable spores in their feces.

To date in Maryland there has been produced under severe handicaps as to labor and funds a total of 94,952 pounds of the spore inoculated dust. This has been distributed according to the original plan, over 47,476 acres, involving 72,815 farms and urban properties. In addition all of the soil used in the incubation boxes has been distributed. This contains a considerable spore population due to the death and disintegration of grubs prior to the end of the normal incubation period. This total of approximately 87 tons has been used to supplement the distribution of talc spore dispersion. In addition to the efforts of the state of Maryland many Federal properties in Maryland such as experimental stations, hospital grounds and army and navy installations have been inoculated by Federal workers.

#### *Results:*

The systematic distribution of the inoculum has resulted in the establishment of the disease in every part of Maryland where the population of grubs is sufficient to create a Japanese beetle problem. There has been a significant reduction in the intensity of beetle population in all the older areas which can be logically attributed, in part at least, to the milky disease. This deduction is based on the known presence and extent of milky grubs as shown by periodic and systematic digging of grubs and particularly by large scale treatments on golf courses.

Outstanding results have been recorded on many large and valuable turf areas. In 1940 the grub population ranged from 20 to 60 to each square foot of sod in the fairways of the Prince George's Golf and Country Club which is located in Maryland just outside of Washington, D.C. The grass was completely ruined. Treatment of the golf course reduced the grub count in a period of nine months to 1 to 3 for each square foot. This low infestation has been maintained without additional treatment for a period of over seven years. This past spring the golf course was in such excellent condition that the club entertained a national tournament. Similar results have been obtained on numerous golf courses in the vicinity of Baltimore City. The milky disease organism has been used to prevent the buildup of excessive grub population and resulting damage, as well as to reduce heavy sod infestations. Treatment of grass on the University of Maryland campus before beetles became numerous in the community has resulted in preventing any obvious grub damage to the treated turf.

#### *Outlook:*

It is quite evident from the reduction in numbers in the older infested areas that a similar and lasting effect may be anticipated throughout Maryland. The spores of Type A milky disease are extremely resistant to heat, cold, excess moisture and desiccation. Therefore it can be expected as sporadic outbreaks occur in the future



that disease will be present and will attack and reduce peak populations of grubs just as it is doing at present. Commercial companies operating under license from the Secretary of Agriculture, U.S.D.A. are preparing and selling the inoculum as fast as they can produce the material.

While the disease is being used specifically for the Japanese beetle, experiments on other grubs indicate the possibility of producing strains that may be specific for the control of other species.

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## LA BOUILLIE SULFOCALCIQUE

Par K. Duprez

*Produit universel, insecticide et fongicide.*

La bouillie sulfocalcique est un produit antiparasitaire, que l'on utilise dans la lutte contre les ennemis des cultures depuis bientôt un siècle. Ces dernières années, elle semblait avoir été supplantée par les produits organiques nouveaux, dont la synthèse a été réalisée industriellement sur une grande échelle. On commence cependant, et certainement avec raison, à y revenir.

On a constaté en effet que les nouveaux produits sont très actifs mais que leur action, insuffisamment étudiée, risque de troubler l'équilibre biologique entre les parasites et leurs prédateurs naturels. La sulfocalcique, au contraire, a une action moins brutale, de sorte que le résultat final est meilleur. Son grand avantage est d'être un des seuls produits ayant à la fois une action fongicide et une action insecticide. L'emploi en est facile et économique, l'innocuité absolue pour l'homme et les animaux domestiques, l'influence sur la végétation très favorable et pouvant augmenter nettement certaines récoltes.

*Composition et action.*

La bouillie sulfocalcique est obtenue par l'action de la chaux sur le soufre en présence de l'eau à une température convenable, souvent par des méthodes assez empiriques. Il se forme un mélange de polysulfures et de corps résultants des réactions secondaires tels que le sulfate, le sulfhydrate, l'hyposulfite etc. C'est ce mélange que l'on utilise comme produit antiparasitaire. Le mécanisme de son action est assez complexe. On a longtemps admis que le pouvoir était surtout dû à l'oxydation du soufre, donnant l'anhydride sulfureux. On sait depuis les travaux de Goodwin, Martin et Salmon, que seuls les polysulfures de calcium sont actifs. Dans certains pays on évalue la qualité des bouillies sulfocalciques d'après leur teneur en soufre des polysulfures. On a admis que le soufre libre a un double mode d'action :

1. Vaporisation directe du soufre dans l'air, surtout dans les cas des serres.
2. Formation à la surface des végétaux de l'hydrogène sulfuré et peut-être de produits polysulfurés solubles. On a parlé d'hydrolyse du soufre. Au point de vue chimique ce n'est pas une hydrolyse, il est vrai semblable qu'il y a pénétration dans des cellules et que des réactions intracellulaires provoquent la formation de composés organosulfurés, lesquels dégagent en se décomposant de l'hydrogène sulfuré.

Quel que soit le mécanisme de cette action, on a constaté que le soufre très fin est en même temps très persistant et très actif. Il ne faut pas non plus oublier que le soufre a une action vivifiante sur les végétaux et un effet favorable sur la végétation et la fructification.

Si l'on avait étudié le principe actif, on connaissait en revanche très mal le rôle de chaque composant du mélange et surtout leur action sur la végétation. L'étude de ces questions a été reprise entièrement à la Station de Recherches Fruitières de Sologne, en France, et certaines précisions ont déjà pu être données. (Voir une communication récente de M. François Robin, Directeur de la Station de Recherches Fruitières de Sologne, à l'Académie d'Agriculture, Séance du 7 juillet 1948). Pendant ces recherches qui se sont poursuivies de 1943 à 1947, on a pu constater que le principe actif est un

corps intermédiaire entre le tétrasulfure et le pentasulfure de calcium, et que le corps nuisible à la végétation est l'hyposulfite de calcium.

Une bouillie sulfocalcique étant particulièrement riche en polysulfures, et présentant une faible teneur en hyposulfite de calcium, serait donc un produit de grand valeur.

L'étude de la fabrication industrielle s'est poursuivie parallèlement, et on arrive aujourd'hui par des procédés spéciaux, à réaliser la fabrication d'une lessive sulfocalcique répondant à toutes les qualités que l'on peut exiger du produit.

A côté de son action fongicide remarquable, notamment contre la Tavelure, la bouillie sulfocalcique a une action insecticide marquée sur un grand nombre de parasites, soit qu'elle les détruise complètement, soit qu'elle réduise considérablement la prolifération des insectes, soit enfin qu'elle agisse comme insectifuge en les éloignant. On peut l'utiliser seule ou en mélange avec d'autres insecticides tels que D.D.T. arsenic, nicotine etc., réalisant ainsi de remarquables bouillies mixtes. Les précautions à prendre sont les suivantes :

1. Eviter le mélange avec les huiles.
2. En combinaison avec des arsénates, employer des produits très purs et exempts d'arsenic soluble.

La bouillie sulfocalcique trouve une très large utilisation dans la pratique horticole et grande culture.

Durant notre étude de la bouillie sulfocalcique comme fongicide et insecticide, nous avons spécialement étudié son action sur l'araignée rouge des arbres fruitiers, (*Paratetranychus pilosus*) qui menace gravement certaines régions productrices. Je vais citer ici q.q. résultats des essais effectués en 1947.

L'étude en vue de déterminer la valeur d'un insecticide comporte deux groupes d'essais :

1. Détermination du pouvoir insecticide et ovicide.
2. Action sur les végétaux.

Nous avons donc effectué des essais systématiques dans ces deux sens. Les essais ont été faits comparativement, pour chaque série :

- 1° au laboratoire
- 2° en plein champ.

Les essais en plein champ comprenaient :

- a) des essais dans un verger de recherches
- b) des essais dans un verger de production.

Prenons d'abord les essais au laboratoire.

#### *Valeur acaricide et ovicide.*

Traitement le 16 mai sur rameaux de pommier, var. Reine des Reinettes, dont les feuilles étaient envahies d'araignées rouges. La pulvérisation a eu lieu au moyen d'une seringue. Voici un exemple des résultats.

Traitement	Nb initial araignées viv.	Après viv.	24 heures mortes	Nb Initial oeufs sur feuilles repérées.
B.S. 10%+Mouill.	168	0	136	146
Geigy 0,1%				
Rameau I.				
B.S. 0,7%+Mouill.	39	0	23	55
Heliosol 0,1%				
Rameau II.				

Des comptages d'oeufs de printemps avaient été fait sur des feuilles repérées mais l'éclosion totale n'a pas eu le temps de se produire avant le dessèchement des rameaux; de ce fait l'action ovicide du produit sur les oeufs n'a pu être contrôlée par des comptages exacts. Sur des feuilles déjà fanées nous avons cependant fait les observations suivantes :

Bouillie sulfocalcique 1 % : beaucoup d'oeufs éclos mais un grand nombre de larves mortes, nombre cependant inférieur au nombre d'oeufs éclos. Ni larves, ni adultes vivants n'ont été trouvés.

Bouillie sulfocalcique 0,7 % : deux larves vivantes sur le rameau, grand nombre d'oeufs éclos.

#### *Traitement des oeufs d'hiver d'araignée rouge en mars 1947.*

Un échantillon d'un rameau a été prélevé sur un pommier de variété Starking Delicious, dont l'écorce était recouverte d'oeuf d'hiver et traité par trempage dans la bouillie sulfocalcique à 2 %.

Q.q. jours après on constatait des éclosions et on observait des larves les une vivantes, d'autres mortes. Sur un échantillon témoin on observait de nombreuses larves vivantes.

En résumé :

La bouillie sulfocalcique à 1 % et à 0,7 % a une très grande action sur les araignées rouges, adultes et larves.

A 2 % elle n'a pas d'action sur les oeufs d'hiver, mais possède une certaine action prolongée sur les larves naissantes due au dépôt excessivement fin et persistant du soufre. A 1 % et 0,7 % elle a aussi une action prophylactique sur les larves en agissant au moins comme insectifuge sinon comme insecticide.

#### *Essais en plein champ.*

##### *A. Action acaricide et ovicide.*

##### *Vergers d'expériences.*

Les arbres traités étaient des poiriers de la variété Louise-Bonne d'Avranches, en cordons verticaux à branches arquées. Ces arbres ont reçu 4 traitements à 10—12 jours d'intervalle, et la pulvérisation a été réalisée au moyen d'un appareil à dos. La série comprenait des traitements à doses croissantes 0,7—1—1,5—2 %. En prélevant des feuilles régulièrement pour examen et comptage, on pouvait très facilement suivre l'action sur l'araignée, et on constatait, comme dans les cas précédent, que le produit agit comme insecticide sur l'adulte et les larves, mais qu'il est sans action sur l'oeuf. On pouvait aussi constater un changement très net de l'aspect général de l'arbre dont le reverdissement était frappant, surtout dans le cas des plus faibles concentrations.

##### *Vergers de productions.*

La concentration utilisée pour ces traitements était 1 %, et l'appareil un pulvérisateur à moteur de 300 litres et d'une pression de 35 Kgs. Un traitement a eu lieu avant la floraison et trois après, à trois semaines d'intervalle. En comparaison avec les produits à base d'huile d'été l'action sur l'araignée adulte a été aussi grande. En faisant plusieurs traitements, on arrive toujours à détruire les larves et les adultes venus depuis le traitement précédent.

##### *Action sur les oeufs d'hivers.*

Nous avons effectué des traitements d'hiver au mois de février aux doses de 10 % et 7 % contre la mousse et les lichens, cochenilles et oeufs d'araignée rouge. En ce

qui concerne ce dernier parasite nous avons pu faire les constatations suivantes le 25 mars :

La bouillie Sulfocalcique, même à forte dose, ne paraît pas efficace contre les oeufs de l'araignée rouge; les éclosions des jeunes larves ont lieu sur les pommiers traités (variété Reinette Baumann) en même temps que sur les arbres témoins. Il semble toutefois que le soufre, après des pulvérisations à 7 ou 10 % puisse agir pendant longtemps, ce qui expliquerait les cadavres d'araignées rouges ou de larves trouvés sur des arbres traités depuis un mois. Sans doute est-ce également la cause de la bonne végétation des arbres traités et de sa couleur vert foncée, alors que les témoins, souffrant visiblement des attaques, d'araignées, avaient un feuillage gris caractéristique et perdaient même leurs feuilles.

Un traitement à forte dose à la Bouillie Sulfocalcique est donc intéressant à la fin de l'hiver sur des arbres très envahis par les pontes d'araignées rouges, et de ce fait dangereusement menacés.

A ces doses, la bouillie également a un pouvoir décapant remarquable, et détruit les assises superficielles des cochenilles.

#### *B. Action sur le végétal.*

Etudions maintenant l'action du produit sur le végétal.

Au mois de juillet nous avons commencé une série d'essais de brûlures. Des groupes de 5 arbres ont été traités à doses croissantes 1—1,5—2—2,5—3—5 % à 10 h du matin par beau temps ensoleillé et très chaud c.à.d. dans de mauvaises conditions pour les brûlures. Les essais ont été faits sur poiriers (Louise-Bonne), pommiers (Reine des Reinettes) et pechers (Carman). Trois jours après, on ne constatait pas de brûlures. Le dépôt de soufre était visible et très régulier. Des essais ont été en outre faits avec mouillants. Ceux-ci étaient des produits à base de dérivés terpeniques. On n'a constaté de brûlure dans aucun cas.

D'autres essais ont suivi ceux-ci, toujours avec des doses croissantes. Les doses étaient les suivantes :

8—10—12—14—16 % et deux séries comprenant une sans mouillant et l'autre avec mouillant. A 8 % sans mouillant on constatait de légères brûlures sur Louise-Bonne; dans l'autre série on ne remarquait de brunissement qu'à 12 %, à 14 % davantage de brûlure et à 16 % les feuilles étaient nettement brûlées. L'augmentation du pouvoir mouillant semble diminuer les risques de brûlures, car le liquide se répand plus uniformément sans former de grosses gouttes. Les sels dissous existant dans la bouillie, même à dose infime, se trouvent forcément dans une plus grande proportion au point d'évaporation d'une grosse goutte, ce qui pourrait entraîner une brûlure à cet endroit. Que les arbres aient supporté d'aussi fortes doses tient à ce qu'il s'agissait ici d'arbres sains ayant une grande résistance par eux-mêmes. Quand il s'agit d'arbres attaqués par les araignées rouges, nous avons fait d'autres observations.

Une série de traitements à trois concentrations différentes a été faite. Des poiriers en espalier et fortement attaqués ont été traités aux doses suivantes : 0,7—1—2 %. Durant l'essai on suivait l'action sur le parasite en prélevant des feuilles pour comptages. Deux traitements identiques au premier ont suivi celui-ci à 15 jours d'intervalle. Déjà après le deuxième traitement on pouvait constater un reverdissement des arbres traités à 0,7 %, mais on a remarqué par contre que sur les arbres traités à 2 % beaucoup de feuilles sont tombées.

*Conclusions.*

Une bouillie sulfocalcique lorsqu'elle répond à toutes les qualités que l'on peut exiger actuellement, a une grande efficacité contre l'araignée rouge des arbres fruitiers, aussi bien à l'état adulte que larvaire, et même à faible concentration (0,7 ‰). Le produit n'est pas ovicide, mais grâce à la très grande persistance du dépôt de soufre provenant des polysulfures, l'action est prophylactique sur les larves naissantes, en agissant au moins comme insectifuge sur celles-ci sinon toujours comme insecticide. A cette faible dose il n'y a aucun risque de nuire à l'arbre, même s'il est fortement attaqué. Si l'on veut utiliser une dose plus forte il faut tenir compte de la résistance propre de l'arbre, qui diminue avec l'intensité de l'attaque. On pourrait dire qu'il faut traiter à une dose variant en sens inverse du degré de l'attaque. Quelquefois il vaut mieux compléter les traitements à faible dose par un traitement de plus, ou si l'arbre reprend de la vigueur après un premier traitement, augmenter la dose aux traitements suivants.

Bien d'autres essais ont été faits dans les cultures les plus diverses, et on a constaté les facilités de très large utilisation de la bouillie sulfocalcique.

Voici en résumé les avantages d'une bouillie sulfocalcique bien préparée :

— C'est un produit très économique pouvant s'utiliser avantageusement en arboriculture, en grande culture et en horticulture.

— Elle est stable, et possède une composition rigoureusement constante, éliminant les risques de résultats irréguliers par suite de variations dans la composition. Elle a une teneur très élevée en soufre actif, et une teneur insignifiante en hyposulfite de calcium.

— Le dépôt de soufre est extrêmement fin, persistant et très actif.

— Elle a une grande action fongicide sur les différentes maladies.

— Elle a une action sur un grand nombre d'insectes, en agissant comme insecticide dans certains cas et dans d'autres comme insectifuge, éloignant les insectes et s'opposant à la ponte de ceux-ci.

— En adjonction avec certains d'autres produits elle permet de réduire la dose de ceux-ci.

— L'action vivifiante du soufre déposé par les polysulfures dans un état de finesse incomparable, en milieu alcalin, peut par traitements réguliers et continus permettre un accroissement de récolte en poids et en qualité.

Un emploi continu et régulier, durant des années, ne risque pas de nuire aux arbres fruitiers.

On peut donc conclure que si d'autres produits sont nécessaires pour lutter contre les parasites animaux et végétaux des plantes cultivées, que la bouillie seule serait impuissante à détruire, celle-ci constitue un des produits les plus intéressants de la pharmacopée agricole.

Il semble que les agriculteurs et horticulteurs, en particulier les producteurs de fruits, devraient attacher beaucoup plus d'importance à ce produit méconnu, et en faire l'objet d'un renouveau de faveur en lui réservant une très large place dans la défense sanitaire de leurs cultures.

## DEVELOPMENTS IN GLASSHOUSE FUMIGATION IN BRITAIN

By G. Fox Wilson

The employment of toxic chemical vapours in glasshouses in England has been practised for nearly 200 years (41). It is well-known that fumigants are almost entirely insecticidal in their action for, with the exception of Sulphur, there have been few fungicidal compounds capable of being applied in a volatile form.

Wastage of material accounts for restricting this method of pest control to enclosed spaces only, including glasshouses, cloches, Dutch lights, mills, warehouses, granaries and ships' holds, though recent developments in the use of Smoke Generators suggest that they, on occasion, may be employed in the field.

Scientific investigators continue their researches on a range of new chemical substances in order to discover even more effective fumigants for controlling the widest range of animal pests without injury to plants. The ideal fumigant should possess the following qualities:—(i) high toxicity to insects and related Arthropods in all stages of their life cycle—the margin of safety between toxicity to the pest and its host plants is often too narrow thereby ruling out many promising chemical compounds; (ii) non-phytotoxic properties to the widest range of plants so that the vapour may be used with safety in houses containing mixed collections of plants; (iii) ready volatility; (iv) easily generated without the use of elaborate apparatus; (v) good powers of diffusion, though the rate is governed by temperature and humidity factors; and (vi) reasonable in price.

While attention is directed to the developments in glasshouse fumigation in Britain, no consideration is given to the subject so far as other countries are concerned, and such information is readily available in chemical and biological literature (25, 40).

The tendency in recent years has been to stress the importance of routine fumigation, and to recommend regular small dosages in preference to infrequent high dosages. This has resulted in advice being given that  $1\frac{1}{4}$  oz. Sodium cyanide is preferable to 1 oz. per 1,000 cu.ft.; that  $2\frac{1}{2}$  fl.ozs. Tetrachlorethane is as effective as 10 fl.ozs. per 1,000 cu.ft.; and so on. The effectiveness of the operation is largely dependent upon the airtightness of the house, upon temperature and humidity, and on the time of year when the operation is carried out.

A brief review is made of the several fumigants that have been in general use in this country for the past 175 years. The arrangement bears no relation to the respective merits of each fumigant, while no mention is made when considering each fumigant as to the range of pests controlled—such data being presented in tabular form (*see* Table 1).

*Nicotine.*

Nicotine has been used as a glasshouse fumigant for a longer period than any other vapour. So long ago as 1773, Weston (41) states, "There is also another method of destroying insects by fumigating them with the smoak (*sic.*) of tobacco, by means of a pair of bellows."

Some of the earlier methods of vaporisation included:—

(i) The soaking of brown paper or old linen in a solution of saltpetre (Potassium nitrate) and, after drying it in the sun, to spread Tobacco thinly over the sheets which

T A B L E I.

*Major Glasshouse Pests.*

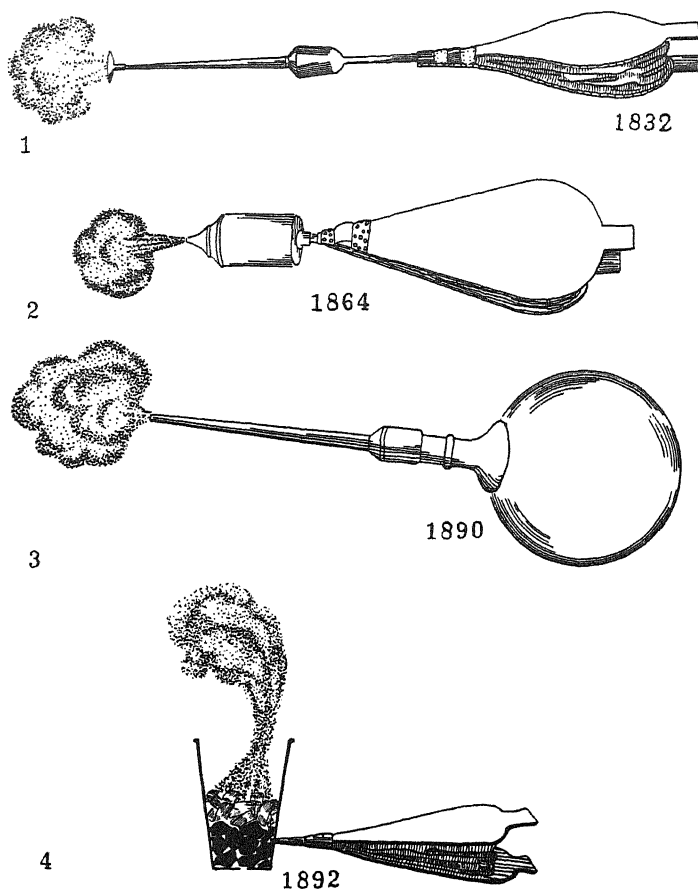
<i>Fumigant</i>	<i>Tetranychus telarius</i>	<i>Thrips</i>	<i>Capsid Bugs (Lygus pratensis)</i>	<i>Aleurodes (T. vaporariorum)</i>	<i>Aphids</i>	<i>Coccids (Scales &amp; Mealy Bugs)</i>	<i>Lepidopterous larvae</i>	<i>Sciarid Flies (Fungus Gnats)</i>	<i>Gall Midges (D. chrysanthemi)</i>	<i>Leaf-Miner (P. atricornis)</i>	<i>Plant intolerance</i>
Azobenzene	+	—	—	—	—	—	—	—	—	—	Schizanthus, Sweet Pea, Zinnia
Benzene Hexachloride	—	+	+	+	(+)	—	+	—	—	+	
D D T	—	+	+	+	—	(+)	+	+	+	+	Cucurbits
HCN	—	+	+	+	+	+	(+)	+	+	+	Tender-leaved plants
Methyl Bromide	+	+	+	+	+	(+)	(+)	(+)	+	(+)	
Naphthalene	+	—	—	—	—	—	—	—	—	—	
Nicotine	—	+	+	—	+	(+)	(+)	+	+	+	Tender-leaved plants; bleaching of blooms.
Sulphur	+	—	—	—	—	—	—	—	—	—	
Tetrachlorethane	—	—	—	+	—	(+)	—	—	—	—	Chrysanthemum, Cineraria etc.

(— no control; (+) partially effective; + good control)

were then tightly rolled like a cigar. A number of flower-pots were inverted upon which were placed the rolls of tobacco, and ignited at both ends—the quantity required being dictated by practice (16). Similarly, the residues from the manufacture of tobacco were soaked in a solution of 2 lbs.  $\text{KNO}_3$  in 1 gallon of water, then dried, and burned in a glasshouse (10).

(ii) The use of a hard-burned flower-pot, 6—8 inches diameter, into which was placed a few live embers, and over them a handful of damp, unrolled coarse tobacco or tobacco paper. A small hole being cut in the side of the pot near its base allowed the nozzle of a pair of bellows to be inserted (*Figure 4*). Slow combustion followed the blowing in of air, and a large amount of smoke was released (24).





*Early Types of Nicotine Fumigators—Bellows and Pot.*

(iii) The moistening of Tobacco leaves, which were placed on the hotwater pipes of a glasshouse. In addition, Tobacco juice was projected on to strongly heated bricks or irons (10).

The original types of Nicotine Fumigators included:—(A) Hand Bellows, (B) Rotary Blowers, and (C) Fumigating Pots.

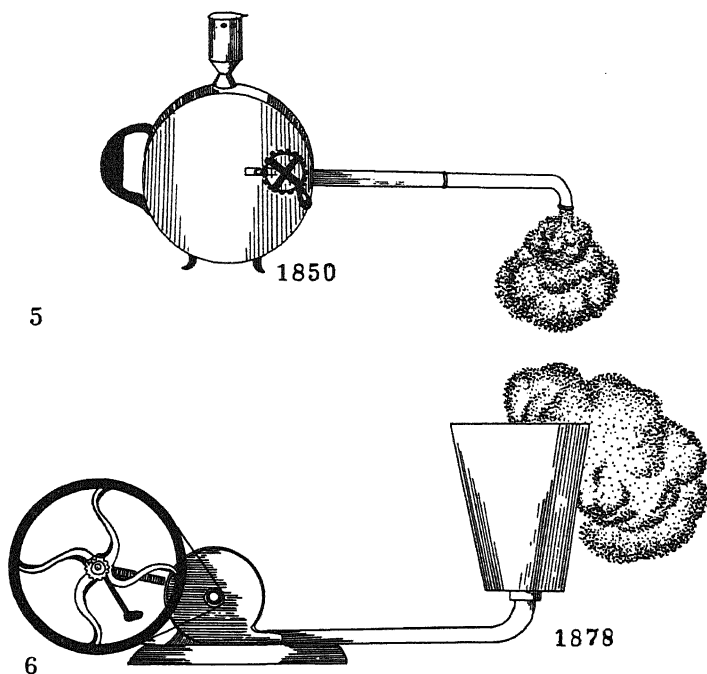
(A) *Hand Bellows*. These comprised a receptacle or barrel to hold the leaves of damaged foreign or home-grown tobacco which, on being ignited and a blast of air driven through it, a powerful issue of smoke was produced through the nozzle, which was then directed against insects or particular plants, or used to fill the atmosphere of a cloche, frame or glasshouse. A diminishing tube delivered the smoke, and the bellows beneath ensured combustion and forced the smoke through the funnel. Some well-known types included:—

Warner's Detached Fumigator (22) ..... — 1832 (*Figure 1*).

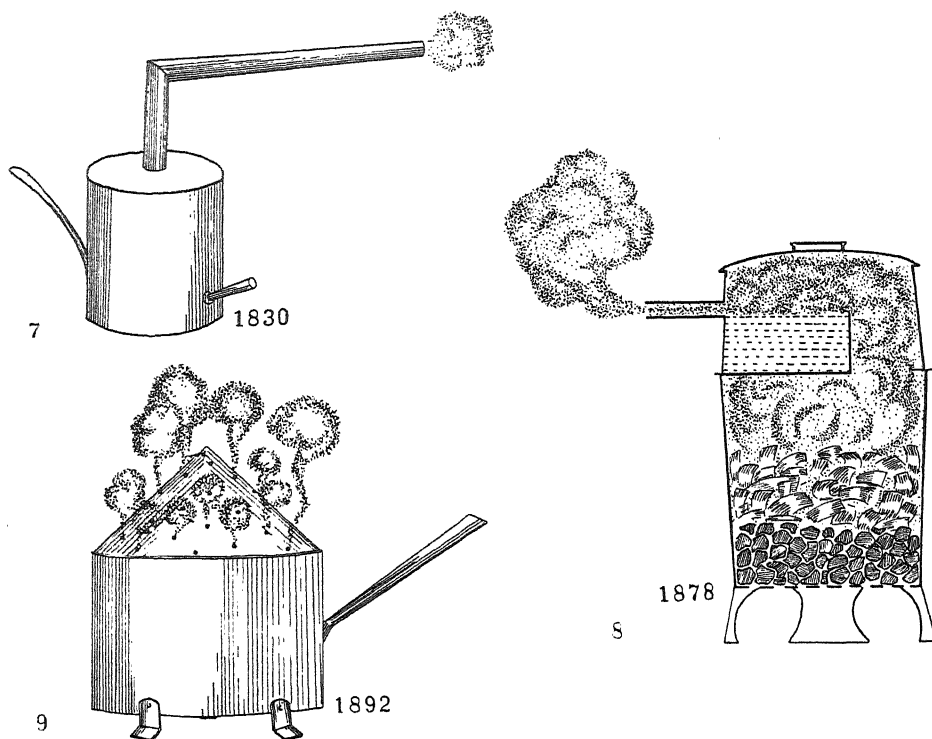
Read's Fumigator (23) ..... — 1834

- The Paxton Fumigator ..... — 1864 (*Figure 2*).  
 William's Amateur Plant Fumigator ..... — 1890 (*Figure 3*).  
 Bloxham's Fumigator (43) ..... — 1892
- (B) *Rotary Blowers*.  
 Brown's Fumigator (2, 24) ..... — 1850 (*Figure 5*).  
 Geach's Fumigator (3) ..... — 1855  
 Dean's Fumigator (38) ..... — 1878 (*Figure 6*).
- (C) *Fumigating Pots*.  
 Pot Fumigator (21) ..... — 1830 (*Figure 7*).  
 Fry's Self-Acting Fumigator (1) ..... — 1850  
 Dreschler's Patent Fumigator ..... — 1870  
 Chatsworth Vaporising Fumigator ..... — 1878 (*Figure 8*).  
 Harber's Worcester Fumigator ..... — 1879  
 Tebb's Universal Fumigator ..... — 1879  
 Elcome's Improved Fumigator ..... — 1884  
 Appleby's Fumigator (43) ..... — 1892 (*Figure 9*).

Later developments were in the form of shreds, sawdust or paper impregnated with Nicotine and  $\text{KNO}_3$ , and allowed to dry. The result was that the paper, sawdust or similar material smouldered on ignition thereby vaporising the Nicotine. It was usual to manufacture these shreds to contain 13—15 per cent Nicotine, and to allow 1 lb. to treat some 20,000 cu.ft. of space. Well-known preparations included Lethorion (*Figure 10*) and Fowler's Vapour Cones; together with Campbell's Rolls (*Figure 12*),



*Early Types of Nicotine Fumigators—Rotary Blowers.*



Early Types of Nicotine Fumigators—Pot Fumigators.

McDougall's Sheets of impregnated cellulose (8) (Figure 13), and Auto-Shreds (Figure 11).

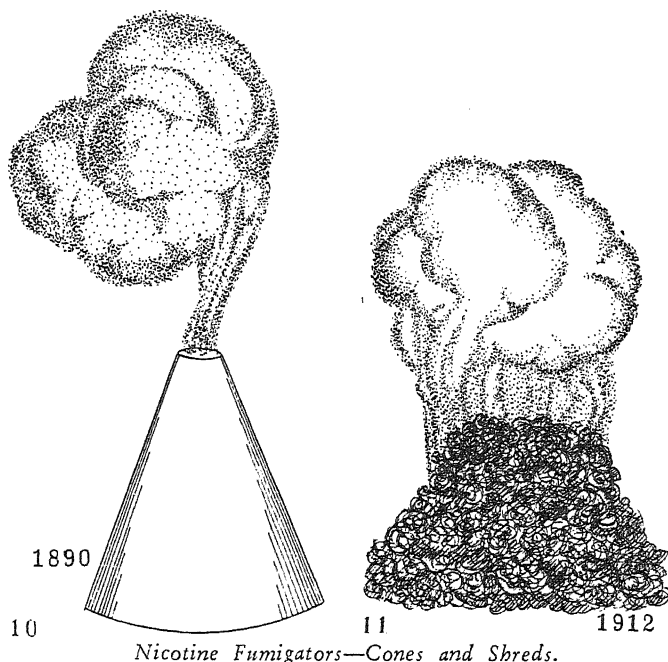
It was the practice later to vaporise pure Nicotine mixed with equal parts of Methylated Spirit in a shallow pan seated on a metal stand over a spirit-lamp, and used at the rate of  $\frac{1}{8}$ — $\frac{1}{4}$  oz. per 1,000 cu.ft. Well-known preparations include Richards' Nicotine Vapour (Figure 14), and Tomlinson & Hayward's Eureka-tine (Figure 15).

The most recent development has been the application of Nicotine, as well as Azobenzene and DDT, from Aerosols, which method is discussed later. The Nicotine is dissolved in a highly volatile liquid, which speedily evaporates from the droplets discharged by the "gun" so that minute particles are diffused throughout the house.

Phytocidal injury may follow the use of Nicotine vapour, namely, the localized effect on plant tissue, including flower discoloration, especially of the open blooms of Primulas (*malacoides* and *obconica*), the partial bleaching of which may follow even normal dosages; and necrosis or "scorch" of tender-foliaged plants, especially tropical Ferns, in stove houses.

#### *Hydrogen cyanide.*

The history of HCN has been given by Woglum (42), who outlined the developments in its use as a glasshouse fumigant (1893—1900), including the replacement of



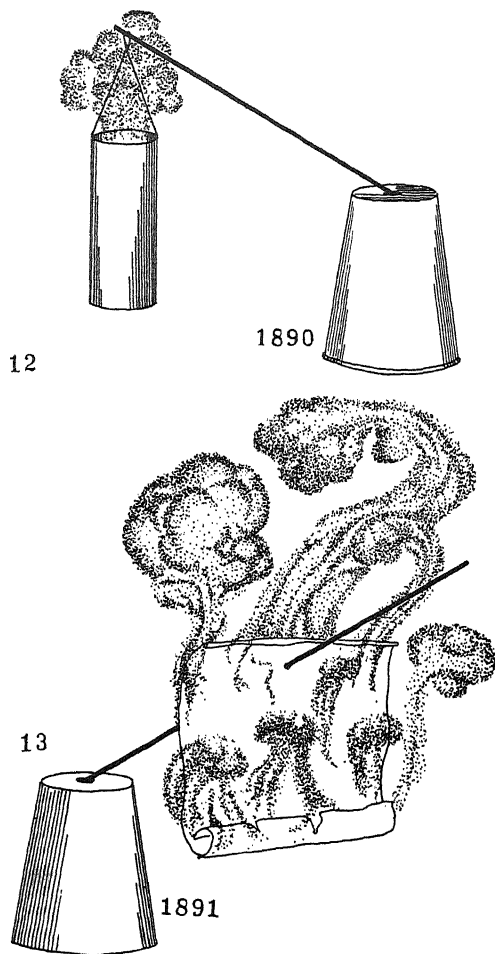
Nicotine Fumigators—Cones and Shreds.

Potassium cyanide by Sodium cyanide (1910—1913), and the introduction of Calcium cyanide (1923).

The gas was formerly generated by the action of Sulphuric acid upon a cyanide by the "Pot Method" (*Figure 16*). Originally, KCN was used, but was replaced later by the cheaper NaCN, which liberates a greater relative amount of the gas. The loose cyanide or a paper-wrapped dosage was dropped into the acid and water, and the operator immediately left the house. To avoid any danger to the operator, an apparatus known as Edward's Safety Cyaniding Machine (*Figure 17*) was designed (4) whereby the dropping of the cyanide into the bowl of acid was manipulated from outside the glasshouse. There also appeared on the market "Safety Cyanide Packages", which consisted of a metal package with thin zinc foil sides containing weighed amounts of NaCN (*Figure 16*). The acid dissolves away the zinc before coming in contact with the cyanide (16). Thereby allowing the operator time to leave the house before the gas is evolved. These generators were effective provided that due allowance was made for additional acid and water for the solution of zinc sulphate formed.

The older "Wet" methods of evolving the gas were superseded by "Dry" methods, including the use of Sodium bicarbonate mixed with Sodium cyanide at the rate of three parts by weight of the former to 1 part of the latter and 1 oz. of the mixture to 1,000 cu.ft. was distributed along the dry paths of the house (36).

A further "Dry" method was the use of Calcium cyanide ("Cyanogas"), which decomposes in the presence of atmospheric moisture to form Calcium hydroxide and HCN (25). Small dosages ranging from  $\frac{1}{16}$ — $\frac{1}{4}$  oz. granular Calcium cyanide are distributed with the aid of a specially designed graduated funnel (*Figure 18*) along the paths of the glasshouse in which the air contains sufficient humidity to permit its



*Nicotine Fumigating Rolls and Sheets.*

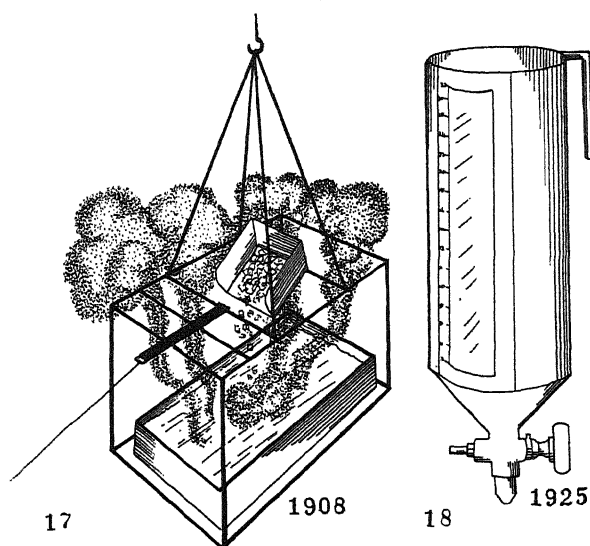
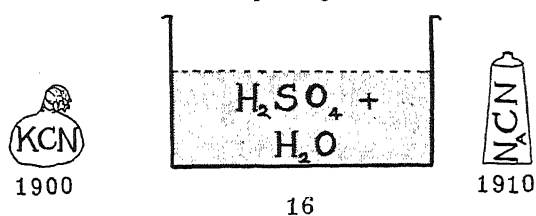
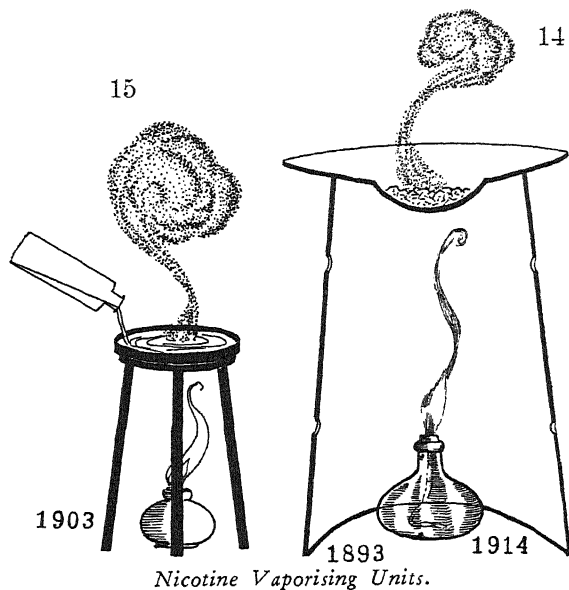
decomposition. The advantage is that there is a slower dispersal of gas than with the "Pot" method, and plants are not subjected to sudden concentrations of HCN.

Hydrogen cyanide was first recommended to practical men in this country against Mealy Bugs in vineries (12).

Certain precautions require to be taken to avoid phytocidal injury, and pre-fumigation rules of procedure are familiar to commercial users of the gas.

Observations have shown that strains of insects, especially Coccids, are likely to develop with increased resistance to HCN.

Modifications were developed in Germany and in the United States of America to produce the gas with the addition of an indicator of a pungent or lachrymatory nature to facilitate its detection and to increase the respiratory activity of the insect, but this development did not receive serious consideration in England.

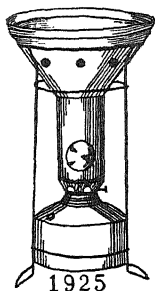


*Hydrogen Cyanide: Methods of Generating Gas.*

*Naphthalene.*

Owing to the failure of Sulphur vapour to provide an efficient control of Red Spider Mite (*Tetranychus telarius* L.), which is resistant to most volatile poisons, Speyer (33) introduced the method of broadcasting Grade 16 Naphthalene in Cucumber houses, at the rate of 3 lbs. per 100 foot run of border with a minimum temperature of 74° F (23° C), a high degree of atmospheric humidity, and an exposure of 36—40 hours. This method, while being highly successful in Cucumber houses, proved less effective in Carnation and Tomato houses where the temperature and humidity figures are lower.

Parker (26), therefore, decided to vaporise the Naphthalene by means of a lamp (Figure 19) to give a slow even volatilisation, and it became widely used in Carnation houses. The time was shortened to 8 hours at the rate of 6—15 ozs. per 1,000 cu.ft. Higher relative humidity is advisable in houses about to be fumigated to avoid any signs of distress on plants fumigated under dry conditions, while low night temperatures are to be avoided during the period of exposure.



19

*Naphthalene Vaporising Lamp.*

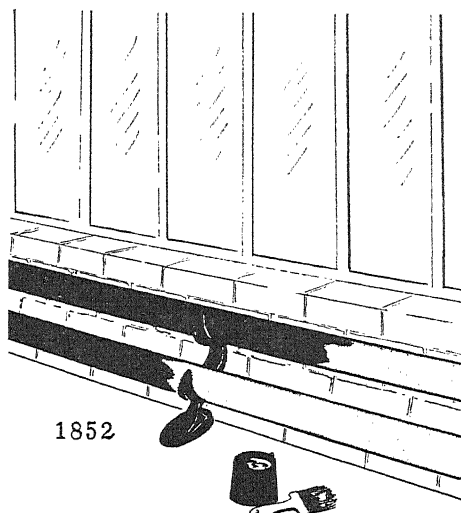
Both methods of application were investigated by Speyer (34, 35), who found that no injury or taint followed Naphthalene fumigation in Cucumber houses provided that the relative humidity figure was high, and that the fruit was exposed to fresh air after treatment. A further method of application outlined by Speyer (33) was to place Naphthalene on the hotwater pipes.

*Sulphur.*

The volatilisation of Sulphur in glasshouses was originally employed as a control for Powdery Mildew of Vine, *Uncinula necator* (Schw.) Burr. [*Oidium Tuckeri* Berk.]. It was found that outbreaks of Acarines, e.g. *Tetranychus telarius* L., were partially controlled in vineries by vaporising Sulphur.

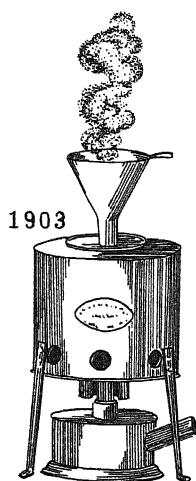
The original practice was to paint the hot-water pipes in vineries with Sulphur (Figure 20) as advocated by Bergman in 1852 (9), and confirmed by Barker *et alii* in 1919 (5). Bourcart (10) recommended that Sulphur should be spread on the heating-pipes once a year so that the plants would be subjected to a Sulphur-containing atmosphere.

Various types of apparatus have been designed for safer and more efficient vaporisation, including Campbell's Patent Sulphur Vaporiser (Figure 21), which was



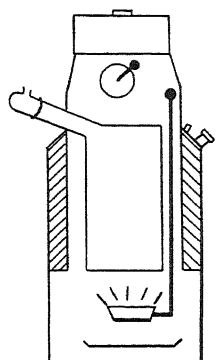
1852

20



1903

21



1921

1927

22

*Sulphur Vapourisation.*

introduced in 1903, and is still used in many glasshouses in Great Britain. This apparatus was designed to keep the source of heat out of reach of the Sulphur to avoid ignition. The Sulphur is boiled, and the vapour evolved condenses to a dense cloud of solid particles in a particularly fine state of division. Care must be exercised since the temperature is raised to a higher degree than that of its ignition point. The danger of ignition is that Sulphur dioxide is evolved with serious consequences to foliage producing severe phytocidal injury.

This danger has been overcome in two ways, namely:—(i) by passing a blast of steam under pressure over molten Sulphur by means of a Rota Generator (31, 39)



(Figure 22); and (ii) by blowing air over the surface of molten Sulphur at temperatures only a few degrees above its melting-point and well below the ignition-point when an abundant cloud of Sulphur in the particulate condition is produced (6).

#### *Tetrachlorethane.*

This liquid was first used experimentally as a specific for the Greenhouse White Fly (*Trialeurodes vaporariorum* Westw.) by Maxwell Lefroy at the R.H.S. Gardens, Wisley, in 1915. Later, Lloyd investigated its use on Cucumbers and Tomatoes, but on account of its high cost it was not considered to compete with the older methods of cyaniding (18, 19). In relation to its effect on insects, it is suggested (20) that, being an organic solvent, it acts upon the waxy covering of both the mature and immature stages of Aleurodids causing it to run thereby upsetting the delicate mechanism of breathing.

The selective action upon plants and the phytocidal effect that follows the use of this vapour in houses of mixed plants is of special interest. Lists of plants tolerant and intolerant are given (13, 26), while there occurs a marked varietal susceptibility to injury in the case of *Chrysanthemum* (32, 35).

The chief advantages of this vapour are its non-inflammability and its general absence of toxicity to human beings so that it may be released in conservatories and glasshouses adjoining dwelling houses where HCN would prove highly dangerous.

Its use is restricted for houses infested with *T. vaporariorum* where concentrations of 2½ fl.ozs. per 1,000 cu.ft. are sufficient to provide an effective control. Infestations of Mealy Bugs (*Pseudococcus species*) require higher concentrations, namely, 5–10 ozs. The roots of plants about to be fumigated should be moist, the temperature between 65–80° F. (18–27° C.), and with high atmospheric humidity to reduce transpiration to a minimum.

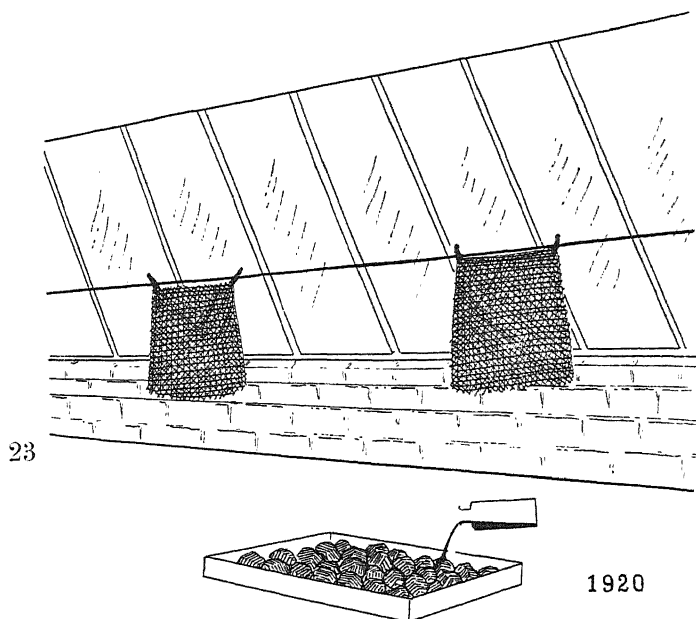
The methods of application have been outlined by Parker (26), and include:—  
(i) sprinkling the fumigant along the paths of the house; (ii) pouring the liquid on to heaps of coke or similar material contained in seed-boxes; (iii) vaporising by means of lamps; (iv) impregnating sacks hung at intervals from the wires of the house; and (v) atomising by means of a mist sprayer. The danger arising from the first method was that *Chrysanthemums* subsequently planted on the site previously sprinkled with the liquid died as though affected with a "Foot Rot". The soil not only smelt strongly of the fumigant six months later, but was permeated to a distance of several feet on either side of the treated paths (Parker, *loc. cit.*). The methods usually employed are Nos. (ii) and (iv) (Figure 23).

#### *Azobenzene, Benzene Hexachloride, DDT.*

The introduction within recent years of these synthetic insecticides has resulted in new methods of dispersal as glasshouse fumigants and, consequently, they will be discussed in the following sections, namely,

- (A) Insecticidal Smokes, Smoke Generators or "Thermofogs",
- (B) Aerosols or Fogs,
- (C) Continuous-phase Aerosols.

A considerable amount of research, both biological and physico-chemical, is required to assess the relative values of these types of generators (27). In addition, the relative costs both of the chemical constituents and of the apparatus concerned in their dispersal are factors of economic importance.



*Tetrachlorethane—methods of Vaporising.*

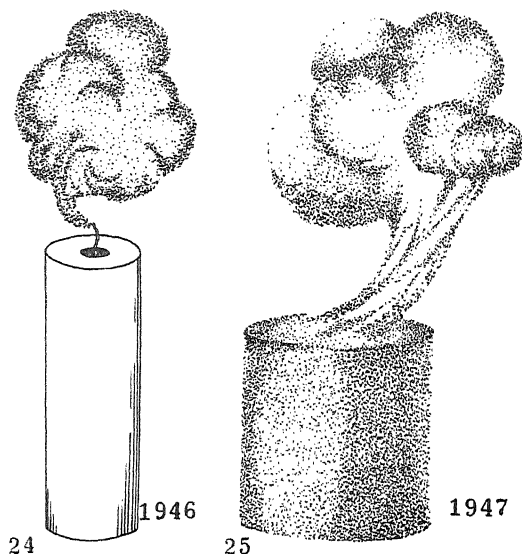
(A) *SMOKES*. There are various methods of producing smokes, including the original method of burning paper impregnated with DDT (11). Later, the insecticide was compounded with a suitable pyrotechnic mixture, which acts as a propellant, and is vaporised when the fuse is ignited. A smoke cloud is produced, which issues through a cooling baffle on top of the cylinder which prevents ignition of the cloud (*Figure 26*).

Two types of generators are available:—(i) a thin-walled metal canister or cylinder with a length of fuse at the top for ignition (*Figure 24*); and (ii) a compressed block of the mixture wrapped in waxed paper, which is removed before ignition (*Figure 25*). The particles of smoke are less than  $1\ \mu$  in diameter thus ensuring even dispersion throughout the glasshouse.

Developments in the production of insecticidal smokes were made during the war (1939–1944), and investigations on this method were carried out by Bateman & Heath (7), who give a description of a pyrotechnic powder consisting of Potassium chlorate and Sucrose with the addition of BHC or DDT. A complication arose whereby HCl may be liberated on storage, and a stabiliser (Magnesium oxide) was added for this purpose.

The chief trouble would appear to be the choice of a suitable pyrotechnic powder which is required to fulfil the following requirements:—(i) to burn slowly when mixed with at least an equal amount of insecticide; (ii) possesses a low ignition temperature to avoid excessive heating before combustion occurs; (iii) give rise only to products compatible with the insecticide; (iv) is not unduly sensitive to friction or to heat; and (v) is not hygroscopic (7).

The advantages of Smoke Generators are that they are reasonable in cost; the operation of fumigation is clean, simple and speedy, so that labour costs are comparatively low; they are self-contained; and their size simplifies storage (27).



*DDT and Azobenzene Smoke Generators.*

Furthermore, the distribution of the insecticide within the glasshouse is considerably more uniform than spray applications so that every part of the house is reached by the smoke, though the residual effect is less than with aerosols.

The disadvantages are that some portion of the active chemical is destroyed during the production of the smoke, while each insecticide has its limitations. For instance, the intolerance of some plants, including tropical Ferns, Schizanthus, Sweet Peas, Zinnias and some others, to the vapour of Azobenzene; and of Cucurbits (Cucumbers, Melons and Marrows) to DDT. The degree of selective toxicity to pests is marked, for instance, DDT has no effect upon phytophagous Acarines, while Azobenzene possesses acaricidal properties only (15). The former danger of 'taint' in the case of BHC has been overcome by the use of the pure gamma isomer.

(B) *AEROSOLS*. Considerable confusion has arisen between the terms "atomisation" and "aerosols". The chief difference is a matter of particle size, wherein those produced by the aerosol method of projection are so minute as to exhibit Brownian movement, and being in the nature of  $0.5-5.0 \mu$ . Atomisation is merely a crude form of aerosol with far larger particle size. The atmosphere acts as a diluent, but the disadvantage is that the particles are deposited almost entirely on the upper surface of the foliage as they settle slowly under gravity laws (29).

The two methods of dispersal are:—(i) solutions of insecticides in propellant gases (chiefly Freon) liquified under pressure and contained in a "bomb" which, when a valve is operated, the insecticide is sprayed from the nozzle by the gas pressure. The disadvantage of this American method is that the bomb must be returned to the manufacturer for recharging. (ii) Solutions of insecticides are dissolved in highly volatile liquids, which readily evaporate from the droplets discharged by the gun (*Figure 27*) operated by a "Sparklet Bulb" releasing Carbon dioxide to expel the solution through a fine nozzle. The emerging droplets are broken up by the expansion

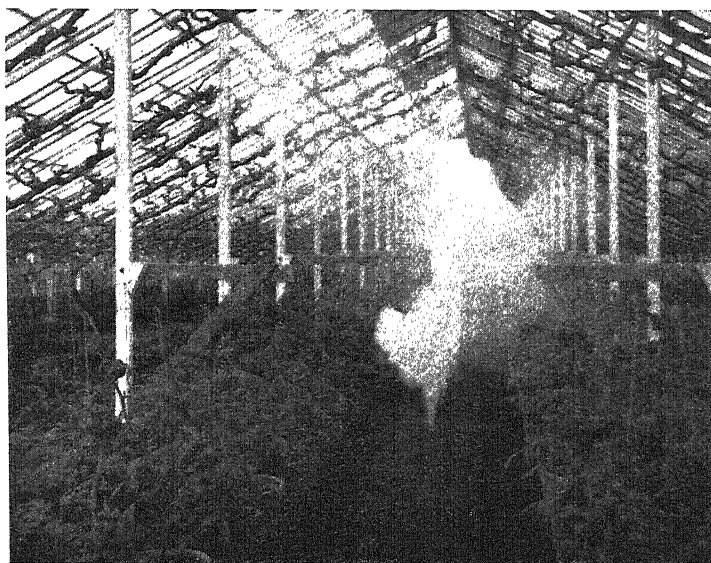


Figure 26. DDT Smoke Generator in action.

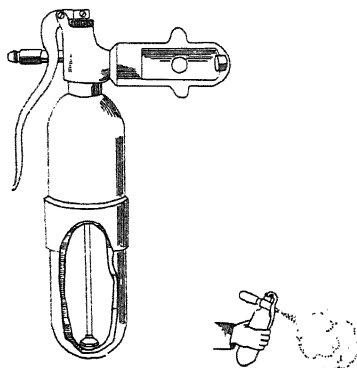


Figure 27. Aerosol showing Aerocide outfit.

of  $\text{CO}_2$ , which becomes dissolved under pressure in the insecticidal solution, and microscopical particles diffuse throughout the atmosphere of the house.

A method employed at the Cheshunt Experimental Station and in many glasshouse establishments is to spray a solution of the insecticide in Acetone into the air with the aid of a standard paint spray-gun operated by compressed air, and fitted with a graduated glass container (28, 29.)

(C) *Continuous-Phase Aerosols.* The fact that aerosols remain in the atmosphere of the house for relatively short periods of time made it desirable to consider other forms of projection. There was developed a continuous-phase aerosol by the "Aerovap" containing DDT dispersed by means of electrical volatilisation (37). The instrument consists of a circular jacket, containing a thermostatically controlled electrical heating element which surrounds a metal cup containing DDT (Figure 28). When the current



Figure 28. Continuous-phase Aerosol or Aerovap *in situ* in Glasshouse.

is switched on the DDT is volatilised and disperses into the surrounding atmosphere. It is stated (37) that the average output of one unit is in the region of 400 mg./24 hours with a median particle size of apparently  $0.5\ \mu$  at the mouth of the cup and an average of between  $0.5$ — $5.0\ \mu$  at normal dispersal points in a room of some 5,000 cu.ft. There may be no advantage in evolving an apparatus that delivers the smaller particle size as the larger crystals of DDT as a residual deposit on surfaces provide a higher toxicity to insects which walk over the area.

Toxicity tests were made on man and warm-blooded animals (rats and rabbits) with no toxic effect.

"Aerovaps" have been installed in a number of houses, kitchens, hotels, restaurants, cowsheds, stables and similar places for the control of House and Stable Flies with excellent results.

Four Industrial Units were installed in the Temperate House at the R.H.S. Gardens, Wisley, Surrey, in March, 1948, to test the effect of a continuous-phase DDT upon a range of insect pests attacking a mixed collection of half-hardy ornamentals. This larger model unit covers an area up to 15,000 cu.ft., and four units were considered necessary in this house, the capacity of which is 30,000 cu.ft. The current used by each unit is less than a 100 watt lamp, which represents a running cost per unit at Wisley of a little below 4.5 pence per 10 hours.

The initial experiment commenced with 3 units working continuously for 24 hours per day, and the results became apparent within 4—6 weeks of switching on the current. The effect is a residual one, and infestations of Thrips (*Heliothrips haemorrhoidalis* Bouché) were the first to be affected. This result was not unexpected—it being known that the uptake of DDT is largely through the tarsal joints of

insects where the cuticle is thinner, and is specially marked in the case of insects possessing large pulvilli (e. g. Thrips.). The effect upon the remaining pest population was as follows:—a rapid control of adult Aleurodids (*T. vaporariorum* Westw.) and of moths (*Tortrix pronubana* Hb.); a slow but definite toxic effect upon Coccids (*Lecanium hesperidum* L. and *Pseudococcus maritimus* Ehrh.); an arresting effect upon Aphides (*Myzus ornatus* Laing in particular); and a reduction in Woodlice populations. No toxic effect was noted upon Tortricid larvae (*T. pronubana*), which pupated normally and, as previously stated, the adults were rapidly killed so that further broods were prevented; or upon Red Spider Mite (*T. telarius* L.); or Slugs. Further work is required on the varying degree with which DDT is absorbed by insects.

The experiment is continuing at Wisley and elsewhere with DDT and Azobenzene, and full details will be published later.

The results already obtained have firmly established the fact that this new development in glasshouse fumigation shows considerable promise. It would appear unnecessary, however, to run the units continuously for 24 hours, especially during the summer when the amount of ventilation necessary in the house results in a considerable loss of vapour. A 12-hour exposure during the night for a period of weeks or months would prove equally effective, and the units to be switched off for such time as circumstances permit and reinfestations of plant pests occur.

#### *Methyl Bromide.*

Methyl bromide is widely known as a very effective fire extinguisher, and was first discovered to possess insecticidal value by Le Goupil (17). Since 1932, its use for pest control purposes has steadily increased, especially in the United States of America (30).

Methyl bromide in England was first used as a fumigant against a pest of horticultural importance by Goodey (14), who showed that infections of the desiccated pre-adult larvae of the Bulb and Stem Eelworm (*Anguillulina dipsaci* Kühn) on Onion seed can be eliminated by the vapour at a dosage of 2 lbs. per 1,000 cu.ft. for 20 hours.

Investigational studies on the use of this vapour as a glasshouse fumigant have commenced at the University of Reading's Horticultural Field Station at Shinfield under the direction of Prof. R. H. Stoughton. It is too early to assess the value of this chemical until tests have been made on a wide range of horticultural plants and upon the pests attacking them.

Two methods of application are suggested, namely, the "fast spray" and the "slow pan" methods; the former being considered to be more suitable under commercial glasshouse conditions.

The toxic hazards associated with fumigation has resulted in the publication of a leaflet, entitled, "Fumigation with Methyl bromide: Precautionary Measures", which was issued by the Home Office in June, 1947. Despite its high toxicity to man, the vapour is in growing demand for fumigating ships' holds, warehouses, vaults and granaries for the control of pests of stored products, including fresh and dried fruits, cereals, seeds, tobacco etc.

There would appear to be a definite future for the application of "fast spray" vaporisation in glasshouses owing to the wide range of pests controlled and the small chance of phytocidal injury resulting provided that the optimum temperature and humidity is maintained during the period of exposure to the gas. An added advantage

is the depth to which the vapour penetrates into dry soil thereby resulting in the control of many soil pests, including Nematodes.

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#### *Summary.*

The developments in glasshouse fumigation in Britain are broadly discussed in relation to past and present methods.

The range of glasshouse pests controlled by each fumigant is given.

The various types of fumigators are described, with special mention of the more recent methods by means of smoke generators, aerosols and continuous-phase aerosols.

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## ACTION PHYSIOLOGIQUE DE L'HEXACHLOROCYCLOHEXANE SUR LES LARVES DE CERTAINS LEPIDOPTERES

Par P. Grison et G. Viel

L'étude de la toxicité de divers produits organiques de synthèse sur les chenilles Processionnaires du Pin, *Thaumetopoea pityocampa* Schiff (Viel et Grison 1948), nous a montré une grande résistance de ces Insectes à l'action de l'hexachlorocyclohexane. Nous avons voulu comparer cette action à celle que HCH est susceptible d'exercer sur des larves d'autres espèces de Lépidoptères, et nous avons déjà entrepris des essais dans ce but, notamment avec : *Thaumetopoea processionea* L., *Lymantria dispar* L., *Euproctis phaeorrbaea* Don., *Saturnia pyri* L., *Vanessa urticae* L., *Operophtera brumata* L.

Nous avons utilisé un produit technique à haute teneur en isomère gamma avec lequel nous avons préparé : d'une part des poudres de concentration variant de 0,1 % à 5 %, la charge étant du talc ; d'autre part des solutions acétoniques à partir desquelles nous avons obtenu des suspensions aqueuses de concentration variant de 0,02 % à 0,2 % de matière active. L'application de ces préparations a été faite par poudrage et pulvérisation tantôt sur les feuilles ou les chenilles seules, tantôt sur l'insecte et son aliment.

Avec cette dernière méthode, dans tous les essais réalisés avec des poudres de concentration allant jusqu'à 2 % la mortalité observée est très faible et souvent même comparable à celle du témoin. Par exemple en 4 jours d'alimentation sur feuille poudrée avec un produit à 2 %, les mortalités suivantes ont été observées chez les larves du 2ème au 3ème stade :

sur les chenilles de :	essai avec H.C.H.	lot témoin
<i>Thaumetopoea processionea</i> L. ....	10 %	5 %
<i>Euproctis phaeorrbaea</i> Don. ....	10 %	5 %
<i>Operophtera brumata</i> L. ....	10 %	0 %

En utilisant des poudres à concentrations supérieures ou des suspensions à 0,2 %, la mortalité devient nettement plus élevée.

Lorsque seul l'aliment est traité, la toxicité paraît être plus faible, à concentrations égales du produit : ainsi, dans les mêmes délais que ci-dessus, avec la Processionnaire du Chêne *T. processionea*, et en employant une poudre à 5 %, la mortalité est de 10 %.

En donnant à des larves du dernier stade des feuilles d'Ortie, *Urtica dioica*, traitées par pulvérisation d'une suspension à 0,02 % et 0,04 % de matière active, on obtient normalement la nymphose chez *Vanessa urticae* ; la quantité d'hexachlorocyclohexane ingérée a été en moyenne d'environ 3,5  $\gamma$  par jour : par exemple une chenille pesant 201 milligrammes et ayant donné une chrysalide de 265 mmg a pu ingérer en 6 jours 21,6  $\gamma$  d'H.C.H.

Dans certains cas il est apparu que l'alimentation des chenilles auxquelles on offrait du feuillage recouvert d'hexachlorocyclohexane était supérieure à celle des chenilles du lot témoin. Par exemple dans les essais avec 20 chenilles de Processionnaire du Pin après 4 jours il reste 19 chenilles dans le témoin ayant consommé 88 aiguilles de *Pinus sylvestris* représentant approximativement 56 gr. de matière sèche, et il reste

18 chenilles ayant consommé 178 aiguilles de Pin recouvertes d'H.C.H. et représentant environ 113 gr. 3 de matière sèche.

Dans le cas de *Vanessa urticae* la consommation semble inférieure dans le lot traité ; cependant les chrysalides sont d'un poids égal ou légèrement supérieur à celui des chrysalides obtenues dans le lot témoin.

Il nous paraît intéressant de remarquer que Slade (1941) avait suggéré que l'isomère gamma de l'hexachlorocyclohexane pourrait exercer une action antagoniste vis-à-vis de celle du méso-inositol dont la configuration spatiale est identique.  $\left(\frac{1.2.4.6}{3.5}\right)$

D'autres auteurs ont mis en évidence le rôle dépressif de l'HCH gamma sur la croissance de microorganismes et surtout la réversibilité de cette action inhibitrice par addition de méso-inositol (Kirkwood et Phillips, 1946).

Dresden et Krijgsman (1947) n'ont pu confirmer ce fait sur les espèces d'Insectes auxquelles ils se sont adressés, notamment sur *Periplaneta americana* L.

Nous pensons que lorsque, chez certaines espèces d'Insectes, l'isomère gamma de l'hexachlorocyclohexane est ingéré en quantité inférieure à la dose toxique, il peut provoquer une stimulation de certaines fonctions physiologiques.

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## ANWENDUNGSMÖGLICHKEITEN VON INSEKTIZIDEN VOM TYPUS HEXACHLOR-CYCLOHEXAN

Von E. Günthart

Alle verwendeten Präparate, z. B. Hexachlorcyclohexan-Suspension (Hexalo), -Emulsionen, -Stäubemittel (Hexapuder), -Streumittel (Hexaterr) zum Mischen mit Kunstdünger und Erde oder regenbeständige Hexa-Kleieköder (CortilanNeu) wurden von der Chem. Fabrik Dr. R. MAAG in Dielsdorf hergestellt, und zwar nach Patent Dupire, Paris, und Lizenz Progil-Péchiney in Lyon und Paris.

Im Folgenden nennen wir immer nur die Sachbezeichnung des verwendeten Präparates mit dem Gehalt an technischem Hexachlorcyclohexan, welches seinerseits ca. 12 % Gamma Isomer enthält.

Wir waren uns von Anfang an darüber klar, dass die Hexa-Präparate nicht in erster Linie Konkurrenzpräparate zu anderen, bisherigen oder neuen organischen Insektiziden, z. B. auch von DDT, sein sollen, sondern dass sie einander in der für die Praxis günstigsten Weise ergänzen sollen. Daher prüften wir die Hexa-Präparate vor allem dort, wo die anderen Insektizide keine befriedigende Bekämpfungsmethode zuließen.

Zuerst zeigte es sich, dass die seit 1945 an Kohlgewächsen und Winterraps besonders stark auftretenden Ceuthorrhynchusarten (Col. Curcul.) sehr gut bekämpft werden können. In Kohlsaarbeeten werden durch gründliche, alle 10 Tage wiederholte Bespritzungen mit 100—150 gr techn. Hexa pro 100 Liter Spritzbrühe die Käfer von Ceut. quadridens Panz. und Ceut. pleurostigma Mrsh. abgetötet, sowie auch deren Eier und Junglarven, die sich im Inneren der Pflanzen befinden. Gleichzeitig werden die Larven der gelegentlich in den Blattstielen minierenden Minierfliegen wie Phytomyza rufipes Meig. abgetötet, ausserdem Kohlerdflöhe, Drehherz gallmücke, Kohlblattläuse u. a. Saarbeetschädlinge vernichtet.

Während Ceut. quadridens und Ceut. pleurostigma mit Hexapräparaten auch kurativ bekämpft werden können, muss Ceut. napi Gyll. vor der Eiablage vernichtet werden, da der Schaden schon durch die Eiablage verursacht wird. Daher müssen gegen diesen Schädling 200 gr techn. Hexa pro 100 Liter Spritzbrühe verwendet werden und die Behandlungen im Saatbeet alle 5 Tage und bei Frühkohl zudem nach dem Auspflanzen noch einige Male wiederholt werden. Diese Behandlungen sind gleichzeitig auch gegen Baris-arten (Mauszahnrüßler) wirksam.

Der Oel-Anbau drohte in grossen Gebieten der Schweiz durch das Auftreten von Ceut. napi unmöglich zu werden. Gegen diesen Schädling gaben 2—3 Bespritzungen mit 200 gr techn. Hexa pro 100 Liter Spritzbrühe sehr gute Resultate (ca. 1000 Liter je ha mit Motorspritze). Die erste Behandlung muss aber frühzeitig, bei Beginn der Eiablage, d. h. meist zwischen 20. März und Anfang April, wenn die Rapspflanzen erst 2—3 cm lange Neutriebe besitzen, durchgeführt werden; die letzte Behandlung spätestens kurz vor Beginn der Rapsblüte. Während der Rapsblüte sollen wegen der Gefährdung der Bienen keine Bespritzungen mit oben genannten Hexamengen stattfinden.

Mit dieser Behandlungsmethode erzielten wir während 3 Jahren sehr deutliche Mehrerträge, 1948 waren z. B. die Rapspflanzen zur Erntezeit bei verschiedenen Versuchen:

in den unbehandelten Parzellen .....	44— 62 cm hoch
in 2—3 mal mit 200 bzw. 150 gr DDT in 100 Lit. Spritzbrühe behandelten Parz. ....	46— 73 cm hoch
in Parzellen, die jeweils im gleichen Zeitpunkt wie DDT mit 200 gr Hexa pro 100 Lit. Was- ser bespritzt wurden .....	70—100 cm hoch.
Die Erträge in diesen Versuchen waren: (pro Are)	
in den unbehandelten Parzellen .....	1,4— 5,8 kg Körner
in den DDT-Parzellen .....	4,3— 7,9 kg „
in den Hexa-Parzellen .....	16,3—20,8 kg „

Durch die Hexa-Behandlungen wurde nicht nur *Ceut. napi* bekämpft, sondern auch ein Schaden von *Meligethes aeneus* F. verhindert und die manchmal auftretenden Barisarten und minierende *Drosophilide Scaptomyza flava* Meig. (= *apicalis* Hardy) bekämpft. DDT wirkte fast ausschliesslich nur gegen *Meligethes aeneus* F.

In weiten Gebieten der Schweiz treten an Möhren und Carotten zwei verschiedene Fliegen auf, nämlich die bekannte *Psila rosae* F., deren zweite Generation in Dießdorf bis zu 75 % der Spätaussaaten befällt, und daneben die weniger bekannte, von R. Wiesmann „falsche Möhrenfliege“ genannte *Phytomyza lateralis* Fall., deren erste Generation bis zu 80 % der Frühsaaten entwertet. Gegen *Phytomyza lateralis* ist bis anhin keine Bekämpfungsmethode bekannt. Beide Fliegen liessen sich mit Hexapräparaten sehr gut und einfach bekämpfen, doch kann diese Wirkung praktisch nicht ausgewertet werden, da die Möhren einen typischen Hexageschmack annehmen können. Vielleicht führen andere, ähnlich wirkende Präparate zum Erfolg.

Im Obstbau können Hexapräparate noch zur Bekämpfung des Apfelblütenstechers *Anthonomus pomorum* L. verwendet werden, nachdem die Eiablage des Käfers schon begonnen hat, also in einem Zeitpunkt, wo es für DDT-Behandlungen zu spät ist. Auch gegen die Sägewespen z. B. *Hoplocampa flava* L. und *Hoplocampa minuta* Christ. lassen sich mit 100—150 gr techn. Hexa pro 100 Liter Spritzbrühe bei mittelspäten und späten Sorten sehr gute und vor allem sehr sichere Resultate erzielen. Eine Schädigung der Bienen trat bei Behandlung unmittelbar nach der Blüte nicht ein, und eine stärkere Vermehrung der Obstbaumspeinnmilbe wurde nicht beobachtet. In Baumschulen und bei nicht tragenden Jungbäumen bewährte sich eine sehr gut benetzende Hexa-Suspension oder eine Hexa-Emulsion als billiges Blattlaus- und Blutlausbekämpfungsmittel.

Ein neues und wichtiges Anwendungsgebiet der Hexapräparate ist die Bekämpfung der Borkenkäfer an Obst und Waldbäumen. Dabei werden 400—500 gr techn. Hexa pro 100 Liter Spritzbrühe oder entsprechende, regenbeständige Stäubemittel verwendet. Um das zeitraubende und zeitbedingte Entrinden der Fangbäume z. B. gegen *Ips typographus* L. zu vermeiden, können sie bald nach dem Legen, z. B. beim Auftreten der ersten Bohrmehlhäufchen mit Hexa behandelt werden. Diese Behandlung zeigte folgende charakteristische Eigenschaften:

- 1) Die frisch eingebohrten Borkenkäfer werden zum grössten Teil vernichtet (besonders bei warmem Wetter. Keine Wirkung auf Eier und Larven). Diese kurative Wirkung wurde bei entsprechenden Konzentrationen von DDT nicht beobachtet.
- 2) Der Belag auf der Rinde schützt die Bäume während mindestens 3—4 Wochen vor Neubefall.
- 3) Der Belag von Hexa hält die neu zufliegenden Käfer nicht ab, sondern tötet sie, während z. B. Kalkarsen oder DDT eine teilweise „Repellent-Wirkung“ besitzen.

- 4) Werden die Bäume vor dem Auftreten der Borkenkäfer- und Larven bespritzt, so werden in erster Linie die Borkenkäfer vernichtet, während die Parasiten viel weniger beeinträchtigt werden. Vögel etc. sind nicht gefährdet.

Auch gegen *Xyloterus lineatus* Oliv. und die 4 wichtigsten Obstbaumborkenkäfer erhielten wir in der Praxis gute Resultate.

Ein Hauptanwendungsgebiet der Hexapräparate ist in der Schweiz die Bekämpfung der Maikäfer *Melolontha melolontha* L. und deren Larven, der Engerlinge. 200 gr techn. Hexa pro 100 Liter Spritzbrühe tötet die getroffenen Käfer ab und der Belag auf den Blättern behält die Wirksamkeit während mehr als 14 Tagen, d. h. rund so lange, bis neue Blätter nachgewachsen sind. Ein Grossversuch in einer Schweizer Gemeinde zeigte, dass sich besonders bei regnerischer Witterung Spritzmittel besser bewähren als Stäubemittel, weil eine längere Wirkungsdauer erzielt wird. Es genügte zu Beginn des Hauptfluges einen 10—20 m breiten Streifen des Waldrandes der Laubwälder zu behandeln. Die neu erscheinenden Maikäfer wurden hier jeweils abgetötet, bevor sie weiter ins Innere des Waldes eindringen. Bei langer Flugperiode ist ev. eine zweite Behandlung nötig. Wird nur der Waldrand behandelt, so wird das biologische Gleichgewicht am wenigsten beeinträchtigt.

Neben der Maikäferbekämpfung spielt die Engerlingsbekämpfung in der Schweiz eine sehr grosse Rolle. 200 gr. techn. Hexa pro Are gaben eine praktisch vollständige Vernichtung dieser Schädlinge, 100 gr genügten in den meisten Fällen für landwirtschaftliche Kulturen wie Getreide, Dauerwiesen etc. Gegen Drahtwürmer, d. h. Larven von *Agriotes*, wirkten schon 50—70 gr techn. Hexa pro Are. Entsprechende Behandlungen, bes. gegen die Engerlinge, wurden in fast allen Baumschulen und neuerdings in grösseren Dauerwiesenarealen durchgeführt.

Gegen die in den Bohnenkeimblättern lebenden Larven der Schalottenfliegen, *Hylemyia cilicrura* Rond. (= *cana* Marq.) und *Hyl. trichodactula* Rond. (= *litura* Meig.) ergab ein Beizen des Samens mit 2,5 gr techn. Hexa pro 000 kg Samen sehr gute Resultate. Ähnliche Behandlungsmethoden könnten ev. bei anderen Pflanzen und anderen Schädlingen verwendet werden.

Ein regenfester Hexa-Kleiköder gab in den schweizerischen Gärtnereien überraschend gute Bekämpfungserfolge gegen die Maulwurfsgrille (*Gryllotalpa vulgaris* L.) und gegen die Gewächshausschabe *Tachycines asynamor* Adel. Hexa-Stäubemittel oder -Köder ergaben eine sehr gute Abtötung der in schweizerischen Gebirgstälern auftretenden Heuschrecken, besonders *Stenobothrus morio* F. und der daneben weniger häufigen *St. lineatus* Panz., *St. biguttulus* L. und *Arcyptera fusca* Pall., doch ist die Bekämpfungsmethode für die Gebirgstäler noch nicht ganz geklärt.

Wir können die charakteristischen Eigenschaften von Hexachlorcyclohexanpräparaten wie folgt zusammenfassen:

- 1) Sie besitzen auch gegen resistenteren Insekten eine gute und rasche Wirkung. Die Wirkungsdauer des Belages scheint verschieden lang zu sein, je nachdem sich die Insekten nur auf dem Belag bewegen oder sich auch von den behandelten Pflanzenteilen ernähren. Die gute Kontakt- und Belagwirkung ist wichtig für die Bekämpfung von *Ceutorrhynchus*-arten, *Baris*-arten, *Halticinen* und *Meligethes aeneus* auf Kruziferen, sowie auch gegen Aphiden (Homopt.), *Melolontha melolontha* und die erwähnten *Ipidae*.
- 2) Der Hexa-Belag besitzt keine „Repellent-Wirkung“, was bei der Bekämpfung der *Ipidae*, *Melolontha*, *Gryllotalpa vulgaris* und *Acrididen* wichtig ist.

- 3) In gewissen Fällen werden auch die Insekteneier und jungen Larven im Innern der Pflanzen vernichtet, was in der Bekämpfung von *Ceut. quadridens*, *Ceut. pleurostigma*, *Scaptomyzella flava*, *Phytomyza rufipes*, *Phytomyza lateralis*, *Hoplocampa*-arten und *Anthonomus pomorum* eine Rolle spielt.
- 4) Hexa gibt eine gute Bekämpfung verschiedener Bodeninsekten, z. B. Larven von *Melolontha*, *Agriotes*, *Psila rosae*, *Hylemyia cilicrura* und *Hyl. trichodactyla*.
- 5) Der typische Geruch von Hexa, der einzelnen Kulturen einen schlechten Geschmack übermitteln kann, bedingt eine gute diesbezügliche Orientierung der Landwirte und eine sorgfältige Anwendung bei einer beschränkten Anzahl von Kulturen. Trotzdem können wir nicht auf die gute Wirkung von Hexapräparaten gegen hartnäckige Schädlinge verzichten.

Die Hauptarbeit wird sein, auf gleicher oder ähnlicher Wirkstoffbasis Präparate zu finden, die keine Gefahr einer Geschmacksbeeinflussung enthalten und welche die vielseitigen Eigenschaften von Hexachlor-cyclohexan besitzen.

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## NEWER ORGANIC INSECTICIDES

By *H. L. Haller*

The world shortage of food, feed, and fiber crops has focused attention upon the importance of conserving these vital materials. One way to assist in this important task is to make an intensive attack on insects that destroy our agricultural crops, fiber crops, and stored grains, and that injure our livestock. Injurious insects can be destroyed in one of several ways but currently chemicals are being used more extensively for this purpose than any other means. This use of chemicals has been due in a large measure to the rapid progress that has been made during the last few years in discovering organic compounds that possess outstanding insecticidal properties. Among the more important ones are DDT, benzene hexachloride (hexachlorocyclohexane), chlordane, chlorinated camphene, and organic phosphorus-containing compounds. Several of these discoveries were made at a time when the need for better insecticides was greater than ever before and when the available world supply of the standard insecticides, the arsenicals, rotenone, pyrethrum, and nicotine, was low. Although the discoveries may appear to some to be due to hastily initiated wartime research and largely fortuitous, this is not the case. Rather, the discoveries are the culmination of extensive explorations for about 80 years. Chemicals have been used for even a longer time to combat injurious insects, but it is only since shortly after the middle of the last century that systematic studies to find new insecticides have been underway.

The early studies were concerned largely with inorganic compounds such as paris green and lead arsenate. About 1910 entomologists became interested in finding out how insecticides kill. The importance of the physical characteristics of the insecticides, such as the wetting and spreading of sprays on foliage and on insects, also was given consideration. A few years later studies were initiated to determine the chemical structures of the highly effective, naturally occurring plant insecticides, the pyrethrins and rotenone. These studies proved fruitful, and the structural formulas that were developed served as patterns for the preparation of organic compounds thought to be toxic to injurious insects. The studies were supplemented by the testing of a large number of synthetic organic compounds which became available soon after the first World War and for which a use was being sought. The two approaches have been profitable and have led to the discovery of a number of compounds highly toxic to insect pests.

One group of chemically related insect toxicants that has attracted much attention is the so-called chlorinated hydrocarbons. The more important members of this group are DDT, TDE (also known as DDD), methoxychlor (the methoxy analog of DDT), benzene hexachloride, chlorinated camphene, and chlordane. The technical grade of each of them is a mixture of two or more isomeric compounds, the insecticidal value of which varies with the product and the test insect. The empirical formula and the total chlorine content of each are given in Table I.

Product	Formula	Percent Chlorine
DDT (dichlorodiphenyltrichloroethane)	$C_{14}H_9Cl_5$	50.01
TDE (dichlorodiphenyldichloroethane)	$C_{14}H_{10}Cl_4$	
Methoxychlor (methoxy analog of DDT)	$C_{16}H_{15}O_2Cl_3$	30.77
Benzene hexachloride	$C_6H_6Cl_6$	73.15
Chlordane	$C_{10}H_6Cl_8$	69.22
Chlorinated camphene	$C_{10}H_{10}Cl_8$	68.54

These products possess one common chemical reaction to which their outstanding insecticidal property has been attributed. In the presence of alcoholic alkali, and in some cases with traces of certain metals, such as iron and aluminium, they lose one or more moles of hydrogen chloride. If this characteristic is a factor in making them toxic to insects, it is only a minor one, as many related compounds are known which likewise yield hydrogen chloride but are practically nontoxic to insects. The speed at which the hydrogen chloride is released from the compound is not a vital factor either, because DDT yields it rapidly whereas the methoxy analog of DDT does not. Other hypotheses have been advanced to account for the toxic action of the chlorinated hydrocarbons, but the solution to the problem is complicated by the variable resistance of different insects.

Of the chlorinated hydrocarbon group of insecticides, DDT, its analogs, and benzene hexachloride are the best known. They have been tested against a wide variety of insect pests the world over and considerable international literature is already available on them. Chlordane and chlorinated camphene are more recent American discoveries and are less well known internationally.

Chlordane was first referred to as 1068 and described as a mixture of isomeric chlorinated hydrocarbons having the molecular formula  $C_{10}H_6Cl_8$ . The technical product is manufactured by two companies in the United States of America under the trade names of "Velsicol 1068" and "Octa-Klor." As with other insect toxicants, chlordane is not used as such, but it is employed in the form of solutions, emulsion concentrates, dusts, and wettable powders. These formulations are available under various trade names. Chlordane is several times as toxic as DDT to house flies and cockroaches but lacks the long-lasting or residual property of DDT. It is also toxic to a wide range of agricultural pests, including the boll weevil, *Anthonomus grandis* Boh., the plum curculio, *Conotrachelus nenuphar* (Hbst.), the squash bug, *Anasa tristis* (Deg.), and ants, *Formicidae*, ticks, *Ixodoidea*, and grasshoppers, *Acrididae*.

Chlordane possesses a somewhat more complex structure than DDT and benzene hexachloride. Chemically it is 1, 2, 4, 5, 6, 7, 8, 8-octachloro-4,7-methano-3a, 4, 7, 7a, tetrahydroindan. In making chlordane, hexachlorocyclopentadiene and cyclopentadiene are first allowed to react to form an addition product having the formula  $C_{10}H_6Cl_6$ . This product is then treated under suitable conditions with chlorine gas to yield chlordane. The independent discovery of the insecticidal properties of this product has recently been announced in a German publication.

Chlorinated camphene was designated as 3956 in early publications. It is made by one American company. The technical product, sold under the trade name "Toxaphene," is formulated as dusts, solutions, and the like for insecticidal use. Chlorinated camphene is toxic to household insect pests and many agricultural insect pests, including the following major pests of cotton: Bollworm (*Heliothis armigera* (Hbn.)), boll weevil (*Anthonomus grandis* Boh.), and cotton leafworm (*Alabama argillacea* (Hbn.)). It has also been found to be quite effective in controlling livestock pests, such as lice and ticks. Like DDT it is relatively slow in its toxic action.

Chlorinated camphene is made by the chlorination of camphene until the chlorine content is  $68 \pm 1$  percent. The product is a mixture of isomeric compounds having the approximate formula of  $C_{10}H_{10}Cl_8$ . The exact structural formula of these compounds has not yet been determined. The camphene is made from pinene, a constituent of turpentine. The conversion of terpenes into insecticides has also been reported by French and Russian investigators. According to a French report the treatment of



pinene with hydrogen chloride yields products having insecticidal properties, and Russian workers have reported that the chlorination of turpentine, which consists essentially of pinene, to a chlorine content of 58 to 60 percent, yields a product that is highly effective against body lice (*Pediculus humanus corporis* Deg.).

The last several years have also seen the development of synthetic organic chlorine-containing compounds that are more specific in their toxicity. 1,1-Bis(*p*-chlorophenyl)-ethanol and bis(*p*-chlorophenoxy)methane have been found to be especially useful against mites. Although both compounds contain organically bound chlorine in their molecules, their structural formulas show little relation to the chlorinated hydrocarbons discussed above. 1,1-Bis(*p*-chlorophenyl)ethanol is especially effective against the European red mite, *Paratetranychus pilosus* (C. & F.). This pest, formerly a minor problem in apple and pear orchards, has become a major one following the use of DDT for codling moth control.

1,1-Bis(*p*-chlorophenyl)ethanol, originally designated as DMC and made by one company in the United States, is prepared by the reaction of 4,4'-dichloro benzophenone with methyl magnesium bromide and subsequent treatment with water. The product is insoluble in water but it is soluble in common organic solvents. It is unstable in the presence of acids and has been reported to decompose on milling with a slightly acid clay. It therefore should be used in neutral or slightly alkaline media.

Bis(*p*-chlorophenoxy)methane has shown its greatest value for the control of the citrus red mite (*Paratetranychus citri* McG.), a serious pest of lemons and oranges in California. The high degree of toxic specificity of this compound is demonstrated by the fact that 50 times the concentration of this compound is required to kill the two-spotted spider mite (*Tetranychus bimaculatus* Harvey) than is necessary for the citrus red mite.

Bis(*p*-chlorophenoxy)methane was first tested under the code number K-1875. It is made by one company in the United States and is available under the trade name Neotran. The compound is prepared by reacting equimolecular quantities of sodium and *p*-chlorophenol in absolute alcohol and subsequently treating the alcoholic dispersion of the phenolate with dichloromethane. The compound is a solid insoluble in water but soluble in a number of organic solvents. It is stable in neutral and alkaline media but is decomposed by dilute aqueous acids.

Another class of organic compounds that has shown amazing insect toxicity is organic phosphorus compounds, the insecticidal properties of which were discovered in Germany. Two products, designated as hexaethyl tetraphosphate and E-605 in Germany, have merited especial attention. Both products are effective against a wide range of insect pests but unfortunately they are also highly poisonous to man. Hexaethyl tetraphosphate in a formulation called Bladan was used by the Germans during World War II as an effective substitute for unobtainable nicotine insecticides. Entomological tests in America have indicated hexaethyl tetraphosphate to be a promising insecticide, especially against mites and aphids. Sizable quantities of hexaethyl tetraphosphate formulated for aerosol use in methyl chloride solution have been used in American greenhouses with considerable success during the past year. In the presence of water or atmospheric moisture hexaethyl tetraphosphate is hydrolyzed to products that are insecticidally inert. This hydrolysis, which is rapid, limits the duration of the insecticidal effectiveness of hexaethyl tetraphosphate but it also minimizes the danger of toxic residues on the crops treated. Spray solutions must be mixed only at the time the spray is to be applied; and dust preparations, as well as the product itself, must be

carefully protected from moisture. Hexaethyl tetraphosphate is obtained by allowing six moles of triethyl orthophosphate to react with two moles of phosphorus oxychloride or with three moles of phosphorus pentoxide. Chemical studies in the United States have shown that the product obtained by either reaction is not the hexaethyl ester of phosphoric acid as was thought to be the case by the German investigations but is a mixture, the principal active ingredient of which is the compound tetraethyl pyrophosphate. Other constituents are ethyl metaphosphate and triethyl orthophosphate, both of which are relatively inactive insecticides. Pentaethyl triphosphate, an unstable ester possessing insecticidal properties, may also be present but this has not been established with certainty.

As produced by either of the reactions above, tetraethyl pyrophosphate is present to the extent of about 15 to 20 percent. Modification of either process by increasing the proportion of the triethyl orthophosphate results in a product designated as tetraethyl pyrophosphate with even more potent insecticidal properties than hexaethyl tetraphosphate. The reaction products are not pure tetraethyl pyrophosphate but are a mixture of ethyl phosphates and polyphosphates containing approximately 40 percent of tetraethyl pyrophosphate. Because economics favor the production of tetraethyl pyrophosphate it will probably displace the use of hexaethyl tetraphosphate.

The product known in Germany as E-605 is an ester of thiophosphoric acid—O,O-diethyl O-*p*-nitrophenyl thiophosphate. For convenience this compound has been designated as parathion in the United States. Parathion has been found to be toxic to many different insects. Because of its ability to kill mites (*Tetranychidae*) which are resistant to DDT and most other insecticides, parathion has aroused considerable enthusiasm among orchardists of the western part of the United States. Parathion is more stable than hexaethyl tetraphosphate and tetraethyl pyrophosphate and its effectiveness persists for a considerable time, reportedly from a few days to several weeks. The disadvantages of parathion are its garlic-like odor and especially its high toxicity to warm-blooded animals. Its acute oral toxicity to rats is 70 times that of DDT, and there are indications that parathion is a cumulative poison. Parathion is made from phosphorus trichloride, sulfur, ethyl alcohol, and *p*-nitrophenol by a series of reactions. Its preparation is not as simple as that of hexaethyl tetraphosphate and tetraethyl pyrophosphate and indications are that technical difficulties have been encountered in the large-scale production of a product of uniform composition.

In conclusion it may be stated that the discovery that a product possesses outstanding insecticidal properties is not sufficient in itself to permit its immediate widescale use. In addition to determining the kinds of pests against which a product is effective a number of problems must be solved. It is necessary to know the effect of the product on beneficial insects, parasites, and predators as well as its toxicity to warm-blooded animals and its possible hazard to man. The dosage that produces acute toxicity, as well as that which may cause chronic poisoning, needs to be ascertained. As few, if any, of the newer insect toxicants are applied as such, it is also necessary to know whether the compound can best be applied as a dust, a spray or an aerosol. Information must therefore be obtained on the solubility of the product in various solvents, and on its compatibility with dust diluents, fungicides, and other insecticides. These and other problems must be solved before a new product can be deemed a useful one in economic entomology.

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## THE CHEMICAL-BIOLOGICAL COORDINATION CENTER OF THE NATIONAL RESEARCH COUNCIL

By *H. W. Kaan*

The Chemical-Biological Coordination Center of the National Research Council was established on July 1, 1946. Its predecessor was the wartime Insect Control Committee of the Office of Scientific Research and Development. This Committee began, in the fall of 1944, to coordinate the work on insect and rodent control which was being carried on by the Office of Scientific Research and Development at the request of the Armed Forces. Some of the problems were—search for new insecticides and insect repellents, search for new rodenticides, development of methods for the dispersal of insecticides, mechanism of action of chemicals on insects and rodents. During the course of this work, many thousands of chemicals were tested and much information was obtained showing the chemical structure of these compounds and their biological action. Some of the important results have been published or will be published. Much information will never be published. In the ordinary course of events, it would remain in war reports, filed in vaults of the National Archives.

Dr. M. C. Winternitz of Yale University, the Chairman, and other members of the Insect Control Committee believed that information of this kind should not be buried but should be organized and kept where it could be easily available to scientists. There should be a place for similar data taken from present and future reports and publications.

To accomplish his purpose, the Chemical-Biological Coordination Center was established with the initial financial support of the Army, Navy and American Cancer Society. The National Cancer Institute of the United States Public Health Service later joined in the support of the Center. It is hoped that the Center, ultimately, will be able to provide all available information on the biological action of any chemical. This is a large order. A number of Subcommittees including specialists in many fields have been formed to carry out this objective. The Biochemical Subcommittee, the Organic Chemical Subcommittee and the Physical Chemical Subcommittee deal with chemical problems. Those dealing with biological problems are Subcommittees for Chemotherapy, Entomology, Malignancy, Mammalogy, Medicine, Microbiology, Pharmacology-Physiology, Plant Sciences, Sanitary Engineering, Veterinary Medicine. These groups, acting as units or through individual members, plan to evaluate data collected at the Center, study methods for critical testing of the action of chemicals, suggest specific research projects dealing with the biological action of a chemical in relation to its structure. Most of these Subcommittees are represented at the Center by a Research Associate or Research Assistant. The present Washington office staff numbers about 30.

The Coordination Center has two main functions: 1. to assemble and organize information on the biological action of chemical compounds, 2. to sponsor the testing (screening) of chemicals about which little is known, so that their biological activity may be determined.

With respect to the first function, the assembling of data, the Center hopes to make use of a number of sources: published literature, reports from industrial, institutional and government laboratories and from screening laboratories, unpublished data from

individuals. The method of recording such data has been worked out very carefully and follows a definite pattern. Data on each chemical mentioned in a given paper or report are recorded on a separate sheet of paper. This so-called Work Sheet will have, on one side, the name of the chemical, its empirical formula, its structural formula, certain physical or chemical data, reference to the Journal or report which contains the information. A special identifying serial number is given to this chemical to aid in locating it in the file. This serial number, also, is on the Work Sheet. On the other side of the Work Sheet are recorded the biological data. These give the name of the organism on which the chemical is acting, a brief description of the test, the results of the experiment. Thus, if an article contains data on the action of 5 chemicals, these will be recorded on 5 Work Sheets—one for each compound. Up to the present time, records have been made for about 15,000 compounds.

After the Work Sheets have been carefully checked, the data which they contain are added to other data related to those chemicals and filed in the Master File. For such compounds as DDT or benzene hexachloride, the Master File will contain much information. For other compounds, there may be the results of only one test. At present, we have records for 3,500 compounds in the Master File. Therefore, if the name of a compound were known, it could be located rapidly in the file and the Master Sheets would contain all of the chemical and biological data available.

In order to locate compounds on the basis of their biological action or to isolate those which have certain functional groups in common, other methods must be used. For this purpose, the Coordination Center expects to use a punched card file. Cards for punching are printed with 80 columns of 12 figures in each column. A code system has been worked out whereby certain figures in definite columns will represent facts concerning the chemical and its biological action. If this chemical is an insecticide, for instance, the figure 2 in column 61 will be punched out. Similarly, certain figures in other columns may be used to represent the structural units of the chemical compound; figures in still other columns may indicate the animal or plant on which the chemical acts. A card can be punched, therefore, to show the structure of a compound and to show its biological action. Many punched cards can be run through a machine which will separate out all of the cards possessing a certain punched hole. The cards can be sorted on the basis of chemical structure of the compound, activity of the compound, or the organism on which the compound acts. By this method, an entomologist could find, for example, all of the phosphorus-containing compounds which had been tested as insecticides and could learn on which insects each compound had been effective. He might learn, in addition, which of these compounds caused injury to plants and which of them were toxic to mammals.

There are various methods for coding (reducing to numbers) the chemicals, the organisms, parts of organisms, the biological action of the chemical and the responses of the organisms. The Center is, at present, trying to work out the most satisfactory method for making the information most readily available—in the way that will be the most useful to the searcher.

The second function of the Coordination Center, sponsoring screening tests, brings contacts with commercial manufacturers of chemicals, with university and government laboratories and with individual scientists. The purpose is, again to determine the biological action of chemicals—of newly-synthesized compounds or those whose action is unknown.

Compounds are sent to the Center by those who synthesize them. Samples of these chemicals are then sent out as requested to government and university laboratories where they are tested as insecticides, rodenticides, fungicides, bactericides, growth regulators, in medical and cancer research. These are standardized tests, in every case, but taken together, they cover a wide range. It may be found from these tests, that a compound which does not act as an insecticide, for instance, may be toxic to some other organism—as in the case of phenothiazine, which does not kill the Japanese beetle but is effective against parasitic worms in sheep and cattle. To date, the Center has received about 1200 chemicals from about 75 agencies. An additional 2500 compounds are available and are being distributed as rapidly as possible. There are 24 laboratories which are authorized to make the screening tests. Seven laboratories, six in the United States and one in England, are either doing insecticide testing at present or will begin testing in the near future. Results of all of the screening tests are sent to the Coordination Center and are added to the files. Thus, they become available to all entomologists and other scientists.

It may be another year or more before the Center is in efficient operation and, meanwhile, we welcome the cooperation and constructive criticism of scientists. Any investigator who is interested in the biological activity of chemical compounds should feel free to make use of the facilities which are available at the Center. It is hoped that the service which the Chemical-Biological Coordination Center can render will find wide use.

Fig. 1. PLAN OF GENERAL BIOLOGICAL CARD

Serial Number	Physical Properties										Chemical Groups										Biological Code									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														

Fig. 3. PLAN OF CHEMICAL CARD

Serial Number	Structural Formula Groups Present										Empirical Formula					Physical and Biological Properties or Other Data				
											Families Present									
	1	2	3	4	5	6	7	8	9	10	C	O+N	F+S	Cl+I	Other Elements					
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1	2.5	7.9	11.1	15.6	17.1	19.2	21.2	23.4	25.6	27.7	30.1	32.3	34.4	35.5	36.5	38.6	40.7	42.8	44.9	
2	1.1	3.3	5.5	7.7	9.9	12.1	14.3	16.5	18.7	20.9	23.1	25.3	27.5	29.7	31.9	34.1	36.3	38.5	40.7	
3	2.2	6.6	11.1	15.6	17.1	19.2	21.2	23.4	25.6	27.7	30.1	32.3	34.4	35.5	36.5	38.6	40.7	42.8	44.9	
4	3.3	9.9	16.7	22.2	25.6	27.7	30.1	32.3	34.4	35.5	36.5	38.6	40.7	42.8	44.9	47.0	49.1	51.2	53.3	
5	4.4	13.3	22.2	31.1	34.5	36.6	38.7	40.8	42.9	45.0	47.1	49.2	51.3	53.4	55.5	57.6	59.7	61.8	63.9	
6	5.5	16.7	27.8	37.7	42.9	45.0	47.1	49.2	51.3	53.4	55.5	57.6	59.7	61.8	63.9	66.0	68.1	70.2	72.3	
7	6.6	19.9	33.3	44.4	50.0	52.1	54.2	56.3	58.4	60.5	62.6	64.7	66.8	68.9	71.0	73.1	75.2	77.3	79.4	
8	7.7	22.2	37.7	50.0	56.6	58.7	60.8	62.9	65.0	67.1	69.2	71.3	73.4	75.5	77.6	79.7	81.8	83.9	86.0	
9	8.8	24.4	41.1	54.4	61.1	63.2	65.3	67.4	69.5	71.6	73.7	75.8	77.9	80.0	82.1	84.2	86.3	88.4	90.5	
10	9.9	26.7	44.4	58.7	65.4	67.5	69.6	71.7	73.8	75.9	78.0	80.1	82.2	84.3	86.4	88.5	90.6	92.7	94.8	
11	11.1	29.9	51.1	66.6	74.4	76.5	78.6	80.7	82.8	84.9	87.0	89.1	91.2	93.3	95.4	97.5	99.6	101.7	103.8	
12	12.2	33.3	57.8	74.4	82.9	85.0	87.1	89.2	91.3	93.4	95.5	97.6	99.7	101.8	103.9	106.0	108.1	110.2	112.3	
13	13.3	35.6	61.1	79.9	88.4	90.5	92.6	94.7	96.8	98.9	101.0	103.1	105.2	107.3	109.4	111.5	113.6	115.7	117.8	
14	14.4	37.8	64.4	83.3	91.8	93.9	96.0	98.1	100.2	102.3	104.4	106.5	108.6	110.7	112.8	114.9	117.0	119.1	121.2	
15	15.6	40.0	67.8	87.8	96.3	98.4	100.5	102.6	104.7	106.8	108.9	111.0	113.1	115.2	117.3	119.4	121.5	123.6	125.7	
16	16.7	42.2	71.1	91.1	100.6	102.7	104.8	106.9	109.0	111.1	113.2	115.3	117.4	119.5	121.6	123.7	125.8	127.9	130.0	
17	17.8	44.4	74.4	94.4	103.9	106.0	108.1	110.2	112.3	114.4	116.5	118.6	120.7	122.8	124.9	127.0	129.1	131.2	133.3	
18	18.9	46.7	77.8	97.8	107.3	109.4	111.5	113.6	115.7	117.8	119.9	122.0	124.1	126.2	128.3	130.4	132.5	134.6	136.7	
19	19.9	48.9	81.1	101.1	110.6	112.7	114.8	116.9	119.0	121.1	123.2	125.3	127.4	129.5	131.6	133.7	135.8	137.9	140.0	
20	21.1	51.1	84.4	1																

## ZINC FLUORARSENATE AS INSECTICIDE

By S. V. *Lundbäck*

In the selection of chemical materials for the control of chewing insects on fruit trees, and apple trees especially, the principal determining factors are their effect on the codling moth, and the plant safety.

For that reason lead arsenate has for a long period of years been the mostly used insecticide for this purpose the world over. No other chemical has then, except under special circumstances, been able to threaten the position of lead arsenate seriously.

The high lead content of lead arsenate has, however, caused objections against its use, and calcium arsenate and zinc arsenate have sometimes been substituted for lead arsenate, but, being less effective against the codling moth and more apt to cause plant injuries, they have not been widely used in this field, notwithstanding their advantage as non-lead arsenates.

In recent years, when new organic insecticides, especially D.D.T. preparations, have come into use for the same purpose because of their high effect against the codling moth, a serious increase in other apple tree pests, such as mites and aphids has in many cases been noted, due to the destruction of their natural insect enemies by these new insecticides.

It has then been necessary to find more effective means for the control of these pests, and new organic spray materials, the handling of which is much more hazardous than lead arsenate, have now been introduced for that purpose.

Considering that heavy mite infestations will often lower the yield for more than one year, there may be advantage in using insecticides for codling moth control that will not kill the predators and parasites of mites, aphids and other pests. For this reason the following particulars of zinc-fluorarsenate, which has advantages over lead arsenate and has shown unusual promise of further development, are given here.

Zinc fluorarsenate is closely related to the basic zinc arsenate or zinc hydroxyortho arsenate. The formula of this arsenate agrees with that of the mineral adamine, with which it has been identified by X-ray methods. Mineralogically, adamine belongs to the "libethenite" group, which among other things is characterized by the fact that the hydroxyl ion forming part of the structure may be easily replaced by the fluorine ion.

By the introduction of fluorine in the zinc arsenate it has been possible to get a much wider range of variation of the chemical and physical properties than with the ordinary basic zinc arsenate. The compounds thus obtained may differ chemically, which is indicated also by differences in toxic action against insects and in plant safety. For practical purposes, however, it has been possible to combine the properties desirable for insect control in products which can be easily reproduced and manufactured.

In comparison with zinc arsenates, these zinc fluorarsenates have been found less injurious to foliage, more toxic to insects, and to have better physical properties. In comparison with lead arsenate they have the advantage of being non-lead compounds and of being compatible with lime sulphur. They are also compatible with the commonly used insecticides and fungicides.

A commercial zinc fluorarsenate product, made up as a spray, has been used in Sweden for fruit trees since 1939, and for most of that time it has been practically

the only spray material used in Sweden for the control of chewing insects on fruit trees. There have been no complaints of the results which have been quite satisfactory as shown by the average yields, the quality of the fruit, and the condition of the tree foliage. This arsenate has been used without any special addition of safening material, but combined with lime sulphur or bordeaux mixture. The previous use of lead arsenate was, however, in many cases the cause of severe foliage injuries.

Not until after the war was it possible to ascertain if zinc fluorarsenate would be suitable also in other countries. The type of zinc fluorarsenate used in Sweden was then found satisfactory where the codling moth develops one generation annually, but not effective enough where this insect is a more severe pest.

An improved type was tried in field tests in the U.S.A. in 1946, where it proved as effective against codling moth in Illinois and Oregon as lead arsenate. It was also tried for cherry fruit fly in Oregon, where it gave complete control and no injury to foliage.

Other tests showed it to be more effective than calcium arsenate against the Colorado potatoe beetle and comparable to rotenone against the potatoe tuber flea beetle.

The zinc fluorarsenate tested in the U.S.A. was in many cases found to be less injurious to the plants than lead arsenate, but generally not safe enough to be used under the local climatic conditions without the addition of some material to reduce arsenical injury.

The high effect of zinc fluorarsenates against insects of the order Coleoptera has been proved by tests in Sweden to prevent the development of various species of bark beetles in unbarked logs of pine and spruce where these beetles act as spreaders of blue stain fungi. Zinc fluorarsenate was found quite superior to lead arsenate and calcium arsenate.

The 1946 test results show that it has been possible to increase the toxic action of zinc fluorarsenate. Subsequent preliminary trials indicate that the toxic action as well as the plant safety can be still further improved.

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## HOW TO KEEP COLLECTED INSECTS FREE FROM MOULD AND PESTS IN ANY CLIMATE

By *René Malaise*

With improving methods of collecting insects in the field by the use of automatic traps, the question of taking care of the obtained insects is growing more and more serious and difficult according to the growing quantity of the crop. Hard-scaled insects, as *Coleoptera*, *Hemiptera*, etc. may easily be attended to. After being sorted out, they may simply be put into bottles with saw-dust, moisted with a few drops of acetic ether. The evaporating acetic ether will prevent the insect-catch from being damaged by mould or putrefaction, and, if the insects also had been killed with acetic ether, their muscles will keep completely relaxed, and a subsequent mounting is thereby much simplified.

*Diptera*, *Hymenoptera*, *Trichoptera*, etc. may simply be kept in glass-tubes, open at both ends. The tubes ought not to be wider than with an inside diameter of up to about 40 mm. and a length of 20 to 25 cm., but may be smaller according to the quantity of insects expected to be inserted.

When used, one end of the tube is closed by strongly compressed inserted cotton. The killed insects, either sorted or mixed, are loosely filled into the tube. The other end of this is then also similarly closed with cotton. By successive tilting of the tube from one end to the other, and simultaneously and alternatively inserting the cotton deeper and deeper into both ends of the tube, the right compactness of the insects inside it is obtained, so that the insects just keep one another in place without being too compressed. The cotton is then soaked with acetic ether, and the tube may be stored away.

The gases from the evaporated acetic ether will kill all bacteria and mould inside the tube and the cotton prevent any new ones from entering even after all traces of the acetic ether has disappeared. The enclosed insects will slowly dry or keep moist depending on the climate, as the humidity of the air may penetrate the cotton and enter or disappear from the tube, but nothing will harm the content of the tube as long as water is not allowed to filter in. Even insect-pests as ants or *Dermestidae* are kept out by the cotton as long as the cotton itself is intact. The filled tube should never be exposed to the direct sun, as the moisture from the enclosed insects then may evaporate and settle on the inside of the tube and soak the insects.

This method of preserving insects in large quantities is rather time-saving as no subsequent drying is requested, but it is not suitable for delicately patterned insects as, e.g. *Lepidoptera*. These must still be kept either in papers or else between layers of cotton or rather sheets of cellulosa. The latter method is more convenient when large quantities are concerned, although the tedious papering of every insect separately is generally considered to be more sure. The papered or otherwise inlaid insects must at first be dried and then be kept air-tight into tins, carefully protected against moisture; not always an easy matter.

For a planned expedition to India I have therefore worked out a combination of this old method and by taking advantage of the preserving quality of the acetic ether and adapted it to papered or inlaid *Lepidoptera*. Larger tins with a round and tightly

closing cover, as used in the thé trade, are utilized. In the cover or in the tin itself a hole is perforated and provided with a short, collar-like tube soldered to the brim. This tube is filled with hardcompressed cotton, and each time the box is opened and new insects or papers are added, the cotton must be soaked with acetic eather. In this way the insects, either in paper or between cellulose, will keep free from mould or putrefaction without previous drying. When the tin is filled, the cover is closed as air-tight as possible, and the cotton is soaked for the last time. The evaporating acetic eather will make the content sterile and it will remain so even after the fumes have disappeared more or less completely, and no germs of mould or bacteria can enter by penetrating the compressed cotton. If the tin is otherwise air-tight, the enclosed insects may keep for very long time even since the last trace of acetic eather has disappeared.

A recently started Swedish expedition to New Guinea was equipped with boxes for *Lepidoptera* according to this new method, and also with saw-dust bottles for *Coleoptera* and *Hemiptera*. Unfortunately the glass-tubes for ordinary insects proved to be so expensive now after the war, that the museum could not afford so high a cost. I fitted then out a large tin, formerly used for bisquits, after the same method as the tins for *Lepidoptera*, with a short brass-tube for cotton incerted into the ordinary cover. The biscuit-box was then filled with empty tobacco-, photographic plate-, or pill-boxes. All these sundry-boxes are supposed to be filled to the brim with insects from the trap, closed, and labelled. The insects in these small-boxes are expected to keep without damage in the fumes of the acetic eather until the large biscuit-box is filled, whereupon the cover is soldered tightly.

That the fumes of the acetic eather may disappear during the storage must be regarded as an advantage where *Lepidoptera*, and other insects apt to become oily are concerned. This extraction of oil from the body of dry insects is a rather ordinary phenomenon, especially if the insects as larvae have lived in wood or in roots, and it is hastened by the influence under long time of fumes from acetic eather or similar chemicals. The concentration of the fumes inside a tube or a box is, on the other hand, expected to decrease quicker by evaporating through the cotton owing to osmotic dispersion than the drying up of the enclosed insects.

By this new method large quantities of insects may be stored in a convenient and rather quick way without previous or subsequent drying of the catch, and regardless of the climate. Insect collections may to-day by this method be brought back from warm-humid tropical rain-forests just as easily as from temperate countries, and a tropical insect collection does not longer mean a collection almost destroyed by mould, and with more or less indeterminable specimens.

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## PROPRIETES INSECTICIDES DE L'HEXACHLOROCYCLOHEXANE ET AUTRES DERIVES DU MEME TYPE

Par M:r et M:me Mouravieff

Etude par la méthode pondérale de la rapidité de l'action insecticide de l'hexachlorocyclohexane, du D.D.T. et du 1068 sur les larves de Doryphore

### Resumé

Après avoir décrit la méthode employée et les produits utilisés on expose les résultats de l'étude du comportement pondéral des larves de doryphore ayant reçu, à l'aide de la micro-pipette, des applications, aux doses médianes léthales, d'hexachlorocyclohexane technique, de D.D.T. et de 1068.<sup>1</sup>

Les variations du poids des larves traitées sont étroitement liées à l'intensité de leur incommodement, ce qui permet de suivre son évolution pendant 48 heures.

Les résultats permettent de conclure au pouvoir insecticide supérieur de l'H.C.H., qui non seulement provoque 50 % de mortalité des larves à un rapport mgr./gr. environ 3 fois et demi plus faible qu'avec le D.D.T., mais encore agit presque immédiatement, tandis que l'action du D.D.T. apparaît seulement de 10 à 20 heures après l'application.

### Introduction

Au cours des essais de laboratoire effectués en 1947 sur l'action insecticide de l'H.C.H. technique des isomères alpha, beta, gamma, delta d'hexachlorocyclohexane, du D.D.T. et du 1068, il a été remarqué que certains produits agissent plus rapidement que d'autres. L'incommodement des larves de doryphore traitées par l'H.C.H. ou par ses isomères se produit en un temps nettement plus court que pour le D.D.T. et le 1068. Etant donné que ce fait, déjà remarqué par d'autres expérimentateurs, constitue un point en faveur de l'H.C.H., il a paru intéressant de consacrer une étude spéciale à ce sujet.

#### I — *Determination ponderale de la variation de poids des larves de doryphore en fonction de l'intoxication* —

Chez les larves de doryphore qui sont très voraces, le développement normal se caractérise par une augmentation rapide de poids qui atteint en 48 heures, dans les conditions de laboratoire, 50 à 60 % du poids initial. L'application de toxiques provoque une diminution ou un arrêt de l'alimentation, ce qui a une répercussion immédiate sur le poids et la croissance des larves.

Ces variations de poids, enregistrées pendant une certaine période de temps, permettent de suivre la marche de l'intoxication et de dresser des courbes caractéristiques de l'action des toxiques.

##### a) *Larves de doryphore utilisées* —

Les larves sont choisies à un stade où l'alimentation est particulièrement abondante et la croissance rapide, c'est-à-dire lorsqu'elles ont un poids de 100 mg. environ. Les larves ont été récoltées journellement dans un champ de pommes de terre et transportées au laboratoire où elles étaient gardées à jeun pendant une heure et demi.

<sup>1</sup> D.D.T. = Dichlorodiphenyltrichlorethum, 1068 =

Ensuite elles ont été pesées et les larves de 100 mgr. sélectionnées, après le contrôle de vigueur habituel.

b) *Produits utilisés* —

Les produits suivants en solution dans l'acétone ont été étudiés :

Produits	Concentration dans l'acétone	Rapport mgr/gr.
H.C.H. technique PROGIL éch. 1947 ....	0,8 %	0,04
D.D.T. éch. S.E.P. 1947 à 75 % .....	2,8 %	0,14
D.D.T. " " " " " .....	1,4 %	0,07
1068 technique .....	1 %	0,05

c) *Mode opératoire* —

Les larves choisies étaient placées individuellement dans des boîtes de Pétri sur des feuilles de pommes de terre et la solution du toxique était déposée sur la région dorsale de la larve au moyen de la micro-pipette. Cette méthode, plus rapide et plus précise que la méthode du pansement toxique, consiste à préparer des solutions acétoniques de toxiques de concentration telle qu'un volume de 0,5 mm<sup>3</sup> déposé sur la larve constitue la dose nécessaire à donner le rapport mgr/gr. voulu. L'acétone s'évaporant rapidement et d'autre part pénétrant partiellement dans l'épicuticule abandonne une mince couche de toxique fortement adhérente. La dose du toxique ainsi déposée dans nos essais correspondait à la dose médiane létale trouvée antérieurement. Le D.D.T. a été en plus expérimenté à une dose moitié plus faible.

Un volume de 0,5 mm<sup>3</sup> d'acétone appliqué sur les larves ne provoque aucun inconvénient comme le montrent les essais avec les larves témoins.

Les pesées se faisaient toutes les heures, sauf en période de nuit et aux heures de repas, de sorte que chaque larve a été pesée 17 fois en 48 heures. Le nombre de larves expérimentées était de 55 pour l'H.C.H., 50 pour chaque dose de D.D.T. et 15 pour le 1068. Les essais témoins comportaient 25 larves.

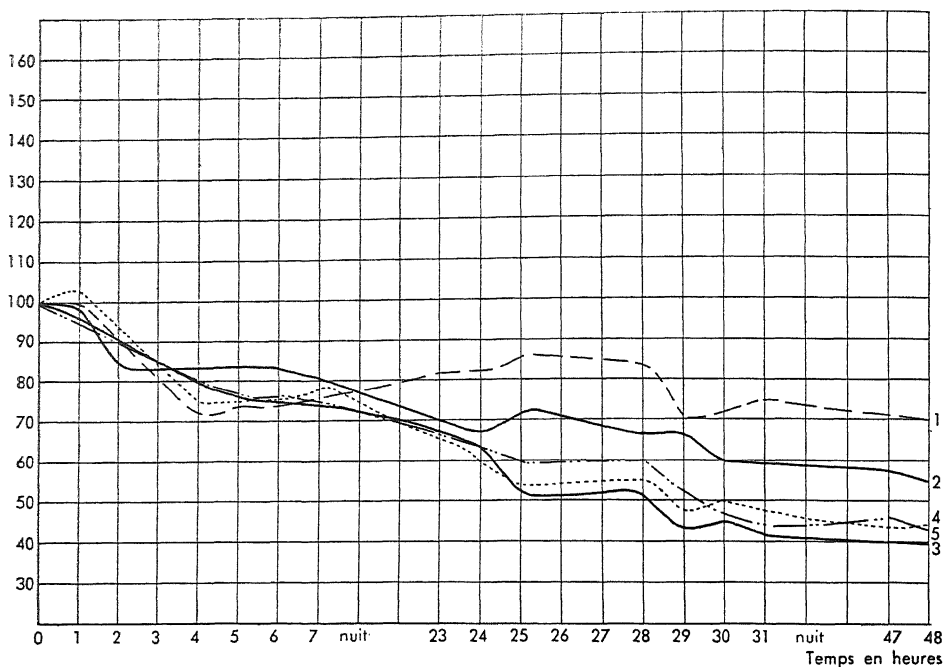
Des larves témoins auxquelles on a fait subir un traitement à l'acétone sans toxique servent de comparaison.

## II — *Résultats obtenus*

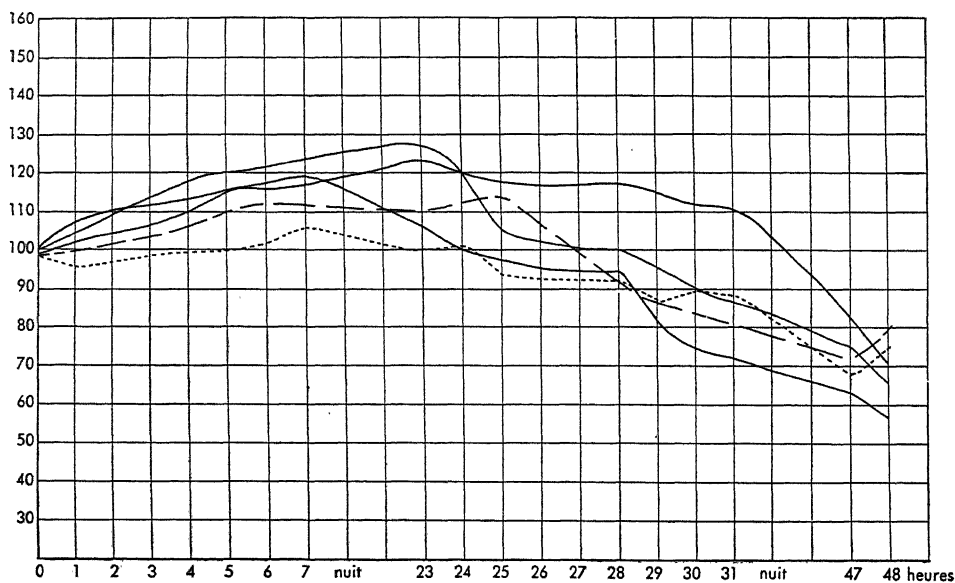
a) *Courbe de variation de poids* —

Chaque pesée individuelle enregistrée toutes les heures est notée. On trace la courbe du poids de chaque larve étudiée en fonction du temps (48 heures). Parmi les graphiques ainsi obtenus, nous avons choisi pour chaque toxique le plus caractéristique et s'écartant le moins de la moyenne. Ainsi le graphique n° 1 représente 5 courbes d'intoxication de 5 larves numérotées de 1 à 5, traitées par l'H.C.H. à la dose médiane létale, soit au rapport mgr./gr. de 0,04. Les deux courbes tracées en traits fins représentent le comportement des deux larves mortes au bout de 48 heures. Les trois courbes tracées en pointillés représentent le comportement pondéral des larves inconvénientées.

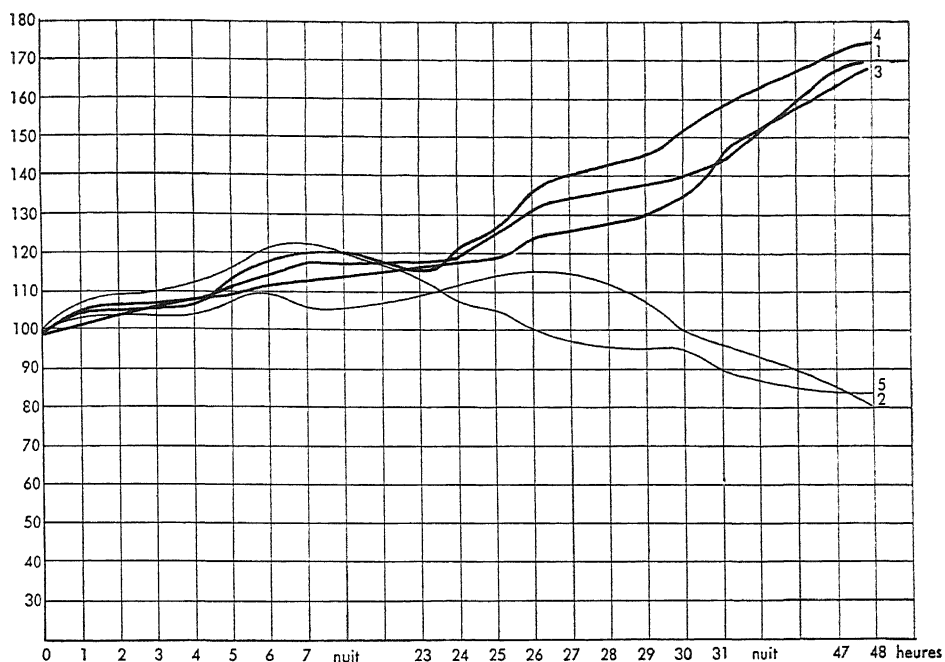
Le graphique n° 2 traduit le comportement de cinq larves traitées par le D.D.T. à la dose médiane létale au rapport mgr./gr. de 0,14 et le graphique n° 3 représente le comportement de cinq larves traitées à la dose moitié plus faible, soit au rapport mgr./gr. de 0,07. A cette dose trois larves restent bien portantes (courbes en traits



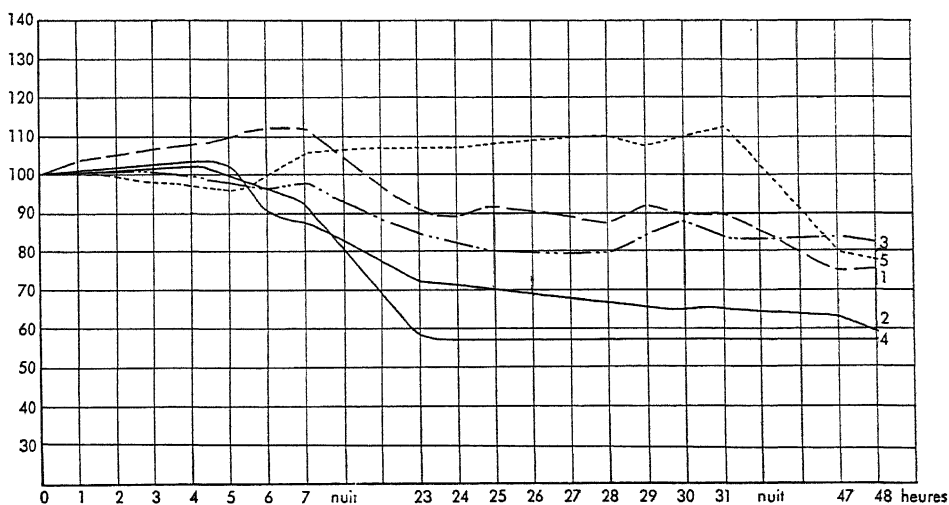
Graphique N° 1. Courbes de variations de poids en 48 H de larves de Doryphores traitées à l'hexachlorocyclohexane technique à 0,8 ‰. Rapport mgr/gr 0,04.



Graphique N° 2. Courbes de variations de poids en 48 heures des larves de Doryphores traitées au D.D.T. à 2,8 ‰. Rapport mgr/gr 0,14.



Graphique N° 3. Courbes de variations de poids en 48 heures de larves de Doryphores traitées au D.D.T. à 1.4‰. Rapport mgr/gr 0,07.



Graphique N° 4. Courbes de variations de poids en 48 heures de larves de Doryphores traitées au 1.068 technique à 1‰. Rapport mgr/gr 0,05.

noirs épais). Le graphique n° 4 représente le comportement des larves après l'application du 1068 et le graphique n° 5 est celui des cinq larves témoins qui sont toutes bien portantes (traits épais).

Le graphique n° 6 qui accompagne le tableau n° 2 est celui de la rapidité de l'action insecticide des trois toxiques envisagés. Les trois courbes de ce graphique sont des moyennes relatives au comportement de l'ensemble des larves traitées pour les divers toxiques; la quatrième est celle des témoins. Afin de mieux faire ressortir le moment à partir duquel l'incommodement devient enregistrable, la partie de la courbe correspondante a été tracée en traits plus fins.

#### b) *Discussion des résultats* —

Les tableaux I et II et les 6 graphiques permettent de dégager l'action spécifique caractéristique de chaque toxique.

Dans le tableau I nous avons noté les différences observées en 48 heures entre le poids initial et le poids final de toutes les larves traitées.

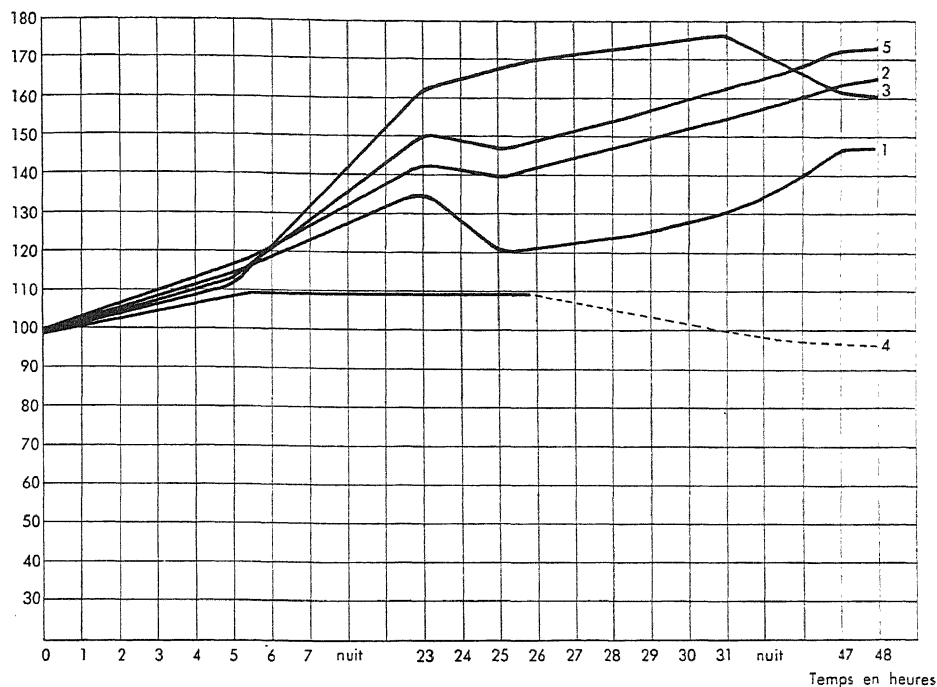
TABLEAU I

Variation moyenne du poids d'une larve de Doryphore de 100 mgr. en 48h.

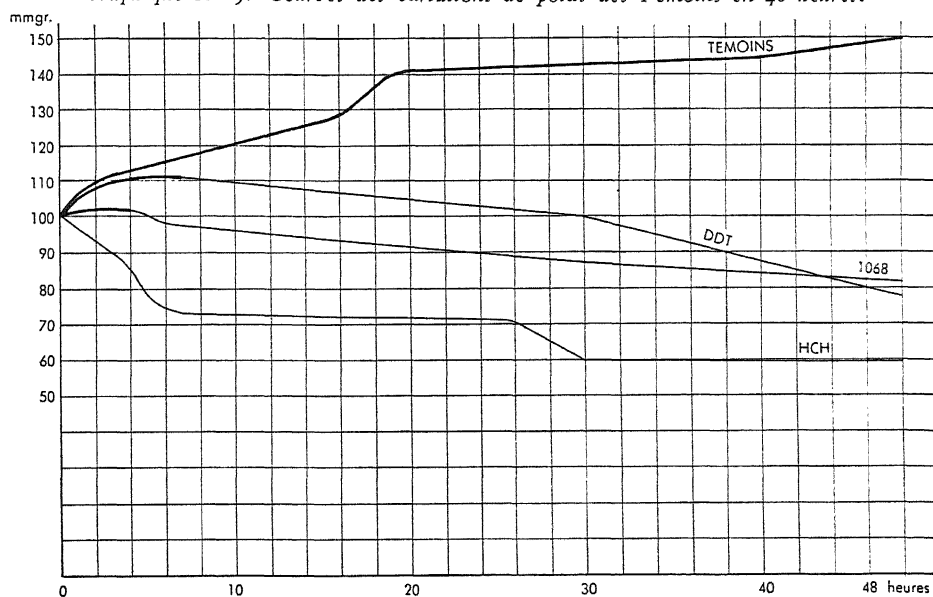
Produit utilisé	Concentration de la solution ‰	Rapport mgr./gr.	Etat des larves après 48 h.	Pourcentage observé	Poids moyen d'une larve après 48 h.	Variations de Poids ‰
H.C.H. technique PROGIL	0,8	0,04	mortes	52,5 ‰	52,4 mgr	— 46,7
	—	—	incom.	26 ‰	95,9 mgr	— 4,1
	—	—	b. port.	21,5 ‰	162 mgr	+ 62,2
D.D.T.	2,8	0,14	mortes	50 ‰	64 mgr	— 36
	—	—	incom.	28 ‰	94,7 mgr	— 5,3
	—	—	b. port.	22 ‰	151,6 mgr	+ 51,6
D.D.T.	1,4	0,07	mortes	22 ‰	70,3 mgr	— 29,7
	—	—	incom.	14 ‰	85,4 mgr	— 14,6
	—	—	b. port.	64 ‰	160 mgr	+ 60
1068 technique	1	0,05	mortes	47 ‰	70,8 mgr	— 29,2
	—	—	incom.	53 ‰	88,3 mgr	— 11,7
	—	—	b. port.	0 ‰	—	—
Acétone		0,5 mm <sup>3</sup>	mortes	0 ‰		
			incom.	4 ‰	100,5 mgr	+ 0,5
			b. port.	96 ‰	156,3 mgr	+ 56,3

#### 1) *Larves mortes* —

L'H.C.H. technique a provoqué pour les larves mortes, à la dose médiane létale de 0,04, une diminution de poids de 47,6 ‰ en moyenne. Le D.D.T. à la dose médiane létale de 0,14 a donné une diminution de poids de 36 ‰ et le 1068 technique dans les mêmes conditions 29,2 ‰. Cette diminution de poids plus élevée des larves tuées par l'H.C.H. correspond à une intense exsudation et à un rejet de liquide, qui n'a pas lieu dans les intoxications par les autres toxiques.



Graphique N° 5. Courbes des variations de poids des Temoins en 48 heures.



Graphique N° 6. Courbes de variations moyenne depoids de larves de Doryphores.  
Rapidite de l'action toxique.



2) *Larves incommodées* —

Les larves incommodées après l'application de l'H.C.H. ont accusé une perte moyenne de poids de 4,1 %. Celles incommodées par le D.D.T. ont accusé 5 % de perte et le 1068 a provoqué une diminution de 11,7 %.

3) *Larves bien portantes* —

Certaines larves plus résistantes arrivent à neutraliser le toxique qu'elles ont reçu à la dose médiane létale et ne montrent pas de perte de poids. Ainsi dans nos essais, 20,5 % de larves traitées par l'H.C.H. ont continué à s'alimenter et ont augmenté de 62,2 % en poids.

TABLEAU II

Variations du poids moyen des larves incommodées et mourantes en fonction du temps (poids initial 100 mgr.)

Produit	Concentra- tion dans l'acétone %	Rapport mgr./gr.	Nombre d'heures écoulées après l'appli- cation du toxique	Variations de poids %
H.C.H. technique	0,4 %	0,04	0	0
			1 h.	— 4,6
			4 h.	— 14,3
			5 h.	— 22,6
			6 h.	— 25,3
			25 h.	— 29,4
D.D.T. S.E.P. 0,75 1947	2,8 %	0,14	48 h.	— 33
			0 h.	0
			1 h.	+ 5,5
			4 h.	+ 10,3
			6 h.	+ 10
			21 h.	+ 5,7
			24 h.	+ 2
1068 technique	1 %	0,05	30 h.	0
			48 h.	— 36
			0 h.	0
			1 h.	+ 0,4
			4 h.	+ 2,4
			6 h.	— 1
			22 h.	— 8
Acétone		0,5 mm <sup>3</sup>	30 h.	— 12
			48 h.	— 19
			0 h.	0
			5 h.	+ 13
			16 h.	+ 29
			19 h.	+ 40
			40 h.	+ 45
			48 h.	+ 56

Les larves restées bien portantes après le traitement par le D.D.T. ont accusé un gain de 51,6 %. Il n'y avait pas de larves bien portantes parmi les larves traitées par le 1068, le poids des larves témoins a augmenté de 56,3 %.

Le tableau II montre l'évolution moyenne du poids des larves expérimentées au cours de 48 heures, sans tenir compte des bien portantes. Comme on le voit, l'action de l'H.C.H. commence à se manifester déjà au bout d'une heure après l'application du toxique, puisqu'on enregistre un abaissement de poids de 4,6 %, cette diminution continue et après 5 heures, elle atteint 22,6 % du poids initial, 29,4 % après 25 heures et 40 % au bout de 48 heures.

Par contre avec le D.D.T., nous assistons d'abord à une élévation de poids se continuant jusqu'à 7 heures après l'application du toxique, la larve continuant à s'alimenter. Une légère diminution de poids acquis commence à devenir enregistrable après 10 heures, mais c'est seulement *après 30 heures que le poids de la larve s'abaisse au-dessous* du poids initial. A partir de ce moment, l'action du toxique devient nette et après 48 heures on enregistre une diminution de 36 % en moyenne.

L'action du 1068 est plus lente que celle de l'H.C.H., mais nettement plus rapide que celle du D.D.T. Les larves témoins s'alimentant normalement augmentent considérablement de poids (56 % du poids initial).

#### Conclusions

L'étude sur le comportement pondéral des larves de Doryphore soumises à un traitement par l'H.C.H. technique, le D.D.T. et le 1068 aux rapports mgr./gr. correspondant à la dose médiane léthale (mortalité de 50 %) permet de dégager les faits suivants :

- 1) L'action toxique de l'H.C.H. *apparaît très rapidement* et la perte de poids des larves est déjà enregistrable 1 heure après l'application.
  - 2) L'incommodement provoqué par le D.D.T. apparaît seulement au bout de 7—8 heures et ce n'est que 30 heures après l'application du toxique que les larves accusent un poids inférieur au poids initial.
  - 3) Le 1068 technique a une action intermédiaire entre les deux autres toxiques.
  - 4) On remarque que la dose médiane léthale de l'H.C.H. technique est trois fois et demi plus faible que celle du D.D.T.
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## THE WETTING OF INSECT CUTICLE<sup>1</sup> "FUNDAMENTAL STUDIES ON INSECTICIDES"

By *Rajindar Pal*

The wetting of insect cuticle by liquids has received little attention in spite of the fact that the effectiveness of almost all contact insecticides depends upon it. Although a considerable amount of work has been done in the past few years upon the mechanism of wetting and spreading of liquids on solids, Stellwaag (1924), English (1928), Wilcoxon and Hartzell (1931) and O'Kane *et al* (1932) are the only workers who have studied the wetting of insects. It was the object of this investigation to study the behaviour of spray droplets when applied to the integument of insects and make quantitative determination of the wetting and spreading power of these liquids.

The soundest method of assessing the wetting powers of fluids is by measuring the contact angles<sup>2</sup> they form with a particular solid surface. To study the wetting of insects by spray liquids it was necessary to measure as rapidly as possible the contact angle of very small droplets on restricted surfaces (such as portions of insects). The apparatus used projected a greatly enlarged image of the drop, the outline of which would be traced very quickly and used for subsequent calculations. (Ebeling, 1938 and Mack, 1936).

Under practical conditions, spray droplets impact on insects with some relative velocity either due to drift of the spray particles or to flight movements of the insect. Measurements were therefore made of the contact angles formed by droplets of water of known size falling on to insects (or to a beeswax surface) at a known speed. It was found that with large drops (5 m.m. diameter) the contact angles formed were somewhat lower than the normal advancing contact angle. With small droplets (0.1—0.5 m.m. diameter) there was no difference. Biological tests were made with thirty species of insects differing widely in the nature of their integument and habitat. The resistance to wetting was found to vary greatly, not only from species to species but also on different parts of the body of a single insect. Legs and antennae are more easy to wet than the wings and other parts of the body. In general, most of the insects were readily wetted by oils and unwetted by water. A few species were both lipophilic and hydrophilic (larvae of *Mamestra*, *Polia*, *Musca*). Insects with hard cuticular lipoids such as *Tenebrio* were more hydrophobic than the blattids with greasy cuticular waxes.

Apart from the chemical nature of the cuticle, irregularities and the presence or absence of hairs were important. Increased roughness lowers the contact angles of liquids with good wetting powers; but has the opposite effect with liquids with poor wetting powers.

Measurements were made of the contact angles formed on individual hairs of *Arctia caca* larvae by spray droplets. The contact angles formed on these hairs by plain

<sup>1</sup> The fuller paper is being published elsewhere; this summarises some of the general conclusions. The work has been carried out during the tenure of a Research Fellowship from the Rockefeller Foundation.

<sup>2</sup> Wetting and spreading are connected with the angle which the surface of the liquid makes with the solid at the point of contact — the contact angle. If the contact angle is zero, the wetting is complete or perfect, if the contact angle is finite, wetting is incomplete or imperfect.

liquids were strongly correlated with the angles formed on smooth *Tenebrio* cuticle or on an artificial beeswax surface; but there was only very rough correlation between the three sets of data when aqueous solutions of wetting agents were tested.

The test liquids included saturated and unsaturated hydrocarbons, mineral oils with varying aromatic contents, organic esters, alcohols and aqueous solutions. Among the hydrocarbons, members of the aliphatic series wet insect cuticle more readily than the aromatic group. The aromatic contents of the oils did not, however, affect their very high wetting powers.

The effects of adding surface active agents to aqueous sprays was investigated. Of the samples tested the most effective wetting agents were those with neutral un-ionised molecules. Surface active agents such as CO9993 (I.C.I. London) ( $C_{16}H_{33}(OC_2H_4)_8OH$  approximately, Cetyl ether of polyethylene glycol) both oil and water soluble, are of particular interest because they not only greatly improve wetting but according to Wigglesworth (1946) they also disrupt the cuticular lipoids.

With increasing concentration of surface active agents the contact angle decreases until an optimum concentration is reached. Beyond this concentration there is no further decrease. The optimum concentration of different surface active agents varied from 0.5 to 5.0 per cent.

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## ORIENTATION DE LA TECHNIQUE DES APPAREILS DE TRAITEMENT ANTIPARASITAIRE EN FRANCE

Par R. Poutiers

L'intensification des cultures, la monoculture en certaines régions, la sélection des plantes en vue de leur rendement ou de la qualité des produits sont des conditions qui ont favorisé souvent la multiplication des parasites dans les cultures. Ainsi, le cultivateur s'est trouvé dans la nécessité de multiplier les traitements antiparasitaires et de les généraliser à des plantes cultivées qui, jusqu'alors, se trouvaient dans un état sanitaire satisfaisant.

Pendant longtemps, des appareils de traitement simples ont été employés, mais il a fallu construire des appareils correspondant aux besoins et des améliorations doivent y être apportées chaque année. Dans ce court rapport, nous étudierons rapidement le perfectionnement des principes, puis les améliorations techniques du matériel lui-même, soit pour la pulvérisation, soit pour le poudrage.

### *I — Les Principes —*

A. — Jusqu'à ces dernières années, les types courants d'appareils de pulvérisation étaient basés sur la pulvérisation mécanique. Une pression plus ou moins forte est exercée sur le liquide qui est projeté par un jet de dimension donnée. Il va sans dire que plus la pression est forte, plus le débit est grand, compte-tenu de la finesse de la nappe liquide due à un jet.

Mais, dans les conditions habituelles des cultures, qu'il s'agisse de grandes cultures, de cultures fruitières, etc. . , l'approvisionnement en eau est souvent difficile. Aussi, les recherches qui sont poursuivies en France, comme à l'étranger, tendent à économiser la quantité de liquide répandue par hectare de culture.

Il s'agit alors, non plus de chasser le liquide sous une pression d'air donnée, mais d'entraîner le liquide à pulvériser par un courant rapide d'air ou de vapeur. On peut ainsi obtenir une finesse extrême de la pulvérisation, et en même temps, réduire la quantité de liquide donnée sur une même superficie de culture. C'est ce qu'on appelle la pulvérisation pneumatique ou atomisation.

Différents moyens ont été envisagés en France. Certains constructeurs (Vermorel, Perray, par exemple) emploient à cet effet un ventilateur, d'autres emploient un compresseur, ou un surpresseur (Bevengut).

D'après les premiers essais réalisés, on peut se rendre compte qu'une centaine de litres de bouillie à l'hectare peut suffire avec ces appareils, alors qu'avec la pulvérisation mécanique, de 800 à 1000 litres à l'hectare sont nécessaires pour obtenir un traitement de même efficacité.

Précisons toutefois que si la quantité de produit actif est la même pour le traitement, le support liquide est donc réduit de neuf dixièmes et ceci est un point extrêmement important en certaines régions où le manque d'eau se fait sentir dans les cultures de vigne, de pommes de terre, de betteraves, etc. . .

Quoiqu'il en soit, la construction des appareils pneumatiques n'en est encore qu'au stade "prototype" et l'on doit compter encore sur la pulvérisation mécanique pour traiter la plupart des cultures. Les constructeurs des appareils de ce type doivent donc

conserver en vue les améliorations de principe à y apporter. Parmi ces améliorations, entre en jeu la capacité des réservoirs qui a été augmentée à 500 et 600 litres. En effet, le temps perdu au réapprovisionnement en liquide, temps mort, est généralement trop important par rapport au temps utile d'application.

D'autre part, la question de la pression optima a été fortement étudiée. C'est d'ailleurs une question qui varie avec la nature de l'appareil de pulvérisation. On peut, dans tous les cas, affirmer que les trop faibles pressions sont aussi inefficaces que les trop grandes.

En effet, la pression ne devrait pas être inférieure à 3 kilog. au centimètre carré pour les appareils à dos. D'autre part, une pression dépassant 30 Kilog. au centimètre carré dans les appareils à moteur semble sans utilité. Dans le premier cas, les gouttelettes sont insuffisamment petites; dans le second cas, si les gouttelettes sont fines, il se produit, d'après les études suisses, un *placage*, c'est-à-dire une agglomération de gouttelettes, en gouttes plus grosses qui produisent un ruissellement au lieu d'une vaporisation. Les auteurs suisses vont beaucoup plus loin encore, puisqu'ils pensent que 8 à 12 Kg au centimètre carré suffisent comme pression optima.

En tout état de cause, nous admettons en France que la pression maximum de 25 à 30 Kilogs est nécessaire et suffisante pour le traitement des arbres à haute tige, l'opérateur pouvant être placé sur une plateforme pour traiter les arbres de grande taille.

B. — La question du poudrage retient également en France l'attention des constructeurs, car d'excellentes formules de poudres antiparasitaires existent actuellement et l'évolution des appareils antiparasitaires doit suivre strictement l'évolution des produits.

Des améliorations substantielles ont, certes, été apportées à la construction de petites poudreuses à ventilateur dont la régularité dans le débit a été assurée.

Mais dans le domaine du poudrage, nous devons signaler une méthode fort encourageante pour l'avenir, c'est le *poudrage électrostatique*, dû aux travaux de P. H a m p e.

Le principe est de créer un champ électrique entre l'appareil à poudrer et la plante que l'on traite. Ce champ est créé en communiquant aux particules, très fines, de la poudre, une charge électrique soit par frottement dans les appareils très simples, soit par une machine électrostatique.

Lorsque la poudre sort du jet, les particules se fixent rapidement sur toutes les parties de la plante, face supérieure des feuilles comme face inférieure et y adhèrent fortement. La répartition est régulière, une faible quantité de poudre se dispersant ailleurs que sur la plante. La plante, par sa charge électrique opposée exerce ainsi une attraction sur les particules de poudre électrisées en sens contraire. Le rendement économique est considérablement accru.

Bien que cet appareil soit encore du domaine du laboratoire, il est à penser que sa fabrication en série commencera sous peu de temps.

Signalons le poudrage humide, au stade essais également, réalisé par Perray et Scitra-Coquart. Dans les appareils à poudrage humide, la poudre est projetée par une large tuyère à grande vitesse en même temps qu'un liquide finement pulvérisé. L'ensemble poudre-liquide se fixe fortement sur les organes végétaux en formant une couche adhérente de produit actif.

Faisons enfin mention du poudrage par avion ou hélicoptère qui a été effectué cette année en France sur vigne dans le Midi, sur pomme de terre dans le Nord, enfin dans le Sud-Ouest contre le Criquet migrateur.

## *II — Le Matériel —*

Aussi bien dans les appareils basés sur les anciens principes que sur les nouveaux, le matériel de construction subit constamment des améliorations, dûes à la nature des produits antiparasitaires employés. Il est évident que les constituants d'un pulvérisateur sont soumis à l'action corrosive des produits et à l'usure mécanique due au passage d'un liquide quelconque.

On a ainsi tendance à abandonner le laiton pour la construction des réservoirs, matière onéreuse et difficile à obtenir. On le remplace par des alliages d'aluminium avec ou sans protection, de l'acier inoxydable, du bois ou des matières plastiques.

Pour la pompe, l'emploi de cylindres chemisés en porcelaine, vitrifiés ou émaillés, se généralise de plus en plus.

La forme des jets est réalisée de différentes manières. Un constructeur (Vermorel) a établi récemment le jet-pinceau. Pour les jets d'ailleurs, une question importante se pose, c'est l'usure de l'orifice. Le diamètre optimum de cet orifice se place généralement entre 12 et 16 dixièmes de millimètre. Mais l'usure étant rapide, le diamètre augmente et la nature du jet se trouve modifiée. Aussi des études ont-elles été faites et ont abouti à l'emploi de métaux spéciaux très durs, pratiquement inusables.

Enfin l'utilisation de jets dits "variables" se généralise maintenant à tous les appareils d'une certaine puissance au moins.

En conclusion, on peut constater en France un mouvement très net vers des conceptions nouvelles tant dans le problème de la pulvérisation que dans celui du poudrage.

Les études poursuivies par les constructeurs, les prototypes établis, les réalisations mêmes sont la conséquence des voies ouvertes par l'utilisation de produits nouveaux antiparasitaires. On conçoit donc facilement l'aide que les uns et les autres peuvent s'apporter mutuellement. C'est dans cet esprit qu'a été constitué récemment un Bureau d'études pour le matériel de lutte contre les ennemis des cultures qui groupe en même temps que techniciens spécialisés, constructeurs d'appareils et fabricants de produits. Ce bureau d'études, en étroites relations avec le Centre technique du Machinisme agricole, est à la disposition des constructeurs d'appareils pour effectuer les mesures rigoureuses du fonctionnement de leurs appareils, en ce qui concerne la régularité de dépôt de produit actif sur les plantes, le débit, la dispersion, etc. . . Par exemple, des essais sont entrepris en différentes sortes de cultures, pour tel ou tel appareil, contrôlés systématiquement. Ainsi, et si c'est nécessaire, les caractéristiques de détail peuvent être modifiées par le constructeur qui n'a pas toujours la possibilité d'exercer lui-même les contrôles les plus rigoureux.

De cette union entre constructeurs, chimistes et hommes de laboratoire jailliront certainement les résultats les plus féconds dans la lutte contre les parasites des plantes cultivées.

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## ANTS AS BENEFICIAL INSECTS

By Fergus J. O'Rourke

*Ants as Beneficial insects.*

As ants are the most successful insects known, probably rarely numbering less than a million per acre and are dominant in very many habitats, it is not surprising that some species should have become pests of importance. However, it should be pointed out that most species are not only innocuous but play an important and beneficial role in the biotope.

Ants are primarily responsible for the removal of dead animals since they are more abundant than other necrophagous insects. Bianchini (1929) has suggested that the lesions produced by ants on human cadavers could be used to determine the length of exposure. Actually the method was used medico-legally in 1929 in Siena to determine the period which had elapsed between the finding of a child's body and the time of depositing it. Experiments with animal corpses have shown that such a method can be accurate to within a few hours.

Ants play an important part in mixing the soil. They bring particles of soil from the bottom layers to the surface. This makes the soil of their hillocks slightly more alkaline than that of the surrounding soil. This is an effect which Grinfel'd (1941) has pointed out is analogous to that caused by earthworms. Pickles (1940) has shown that the same holds for our species *Lasius flavus*. Their mounds showed a greater difference in pH. after rain, due to the fact that mound building occurs especially after rain (cf. Pickles 1941 B). As much as 10 grams of soil a day may be brought to the surface by a single colony of this species. Over a period of 20 days 60 grams (approx. 2 ozs.) were brought up. Over 8 weeks observation in 1942 three colonies brought 4043 gr. (13 ozs.) of soil to the surface i.e. 134.8 grams (4 ozs.) per colony. Unfortunately this species builds permanent mounds which may last for long periods and these tend to be rather a nuisance in unploughed land. In this country they are often accredited to moles, although there are no moles in Ireland. Even William Gould (1747) fell into the error of believing that the mounds in which the ants lived were produced by moles, and that later the ants occupied the mounds.

The activities of *Lasius niger* (Pickles 1943 A) are of special interest for, not only are soil particles used as in the case of *L. flavus*, but also organic material. Furthermore their mounds are only temporary because they are used as nurseries. Thus this species not only improves the soil physically but also chemically by mixing organic matter with it. Pickles has continued his studies in North Africa and has shown (1945) that in 56 days *Pheidole pallidula* excavated in an area of 143 sq.ft. 43.7 ozs. (approx. 14.00 grams) of soil at the rate of 0.77 ozs. per day (approx. 22 grams) and that this was laid on the surface at an average weight of 0.31 ozs. (approx. 10 grams) per sq.ft. in 56 days. If we assume that the ants are inactive for approximately 100 days in the year then the total weight of soil brought to the surface per acre per year would be over a ton (avoirdupois) or nearly one and a half metric tons. Pickles showed (1941 A and 1943 B) that building operations in *Tapinoma nigerrima* are stimulated, as in *L. flavus*, by light rain which makes the soil workable. Heavy rains on the other hand wash the accumulated soil into the surrounding ground. It is clear that ants, especially in the tropics, play an important part in the dynamics of soil circulation.



Talbot (1934) has shown that ants also play an important part in the succession of log decay. They hasten the early stages by opening up galleries in the logs. In the later stages they tend to slow down the process by bringing up raw sand or clay to the surface. There is no doubt that in this country the same holds true, since many of our species will nest in logs which offer a very equitable microhabitat. There is little tendency to pile up earth in the later stages of decay so that in these islands the whole succession is hastened.

While there is little quantitative evidence available it is certain that ants are among the greatest enemies of noxious insects. Stumper has calculated that the inhabitants of each nest of *Formica rufa* destroy over 50,000 insects per day. Ratzeburg showed that the trees of forests which have *F. rufa* colonies beneath them are preserved like so many oases from destruction by Coleoptera (Forel 1928:1:258). It was on this account that a law was made in 1880 in Germany prohibiting under penalty of a month's imprisonment or a fine of 100 marks the destruction or disturbance of *rufa* nests (Wheeler 1910:654). This species is verging on extinction in Ireland and it should be protected where possible. Eidmann (1929) has pointed out that in the pin-moth epidemic in Northern Germany in 1924 local areas up to five acres containing ant hills of *Formica rufa* remained practically uninjured. In another paper (1930) the same author showed that in one summer a large colony of this ant destroyed about two million insects. A million or so of these were harmful and only about a quarter of a million were useful species.

Forel (1928) has calculated that in Switzerland a *F. pratensis* colony destroyed some 40,000 insects per day. This figure is very similar to that of Stumper. Vosseler considers that the Dorylinae of Africa are a blessing to the crops. He estimated that in ten days a single colony of *Anomma* cleared 1,600,000 insects from an area of 10,000 sq. metres. Escherich believed that the future of tropical plantations in Africa would depend on *Anomma* and *Dorylus*. Not all insects are subject to the attack of ants. Stager (1929 B) has shown that certain insects are protected against their attacks. For example, the delicate larva of *Coccinella septempunctata* protects itself by emitting a yellow liquid. This is very offensive to the ants clogging up their mouth parts. Other larvae such as *Orgyia antiqua* are protected by long thick hairs. I have found that the pond skater *Velia currens* (Hemip.) will not eat ants dropped on the water surface. The bugs rush up and in some cases seize the ants (*Myrmica rubra*) but they soon release them. In this case the *Myrmica* are probably protected by their hard integument. Forel (1928) notes that "as early as the XIIth century the Chinese reared and protected ants to destroy the caterpillars which ravaged their orange and mandarin plantations. Raciborski even says that a class of workers called ant gatherers was formed in China for the purpose." Morley (1939) has suggested that the ants were of the genus *Polyrhachis*.

Nicol (1943) records that the earliest written record of the movement by men of one insect to control another is that made by the Swede Forskål in 1775. It appears that the date Palms of Arabia were seriously threatened by ants and that they were controlled by predatory ants brought by the growers every year from the mountains.

In the United States the cotton boll weevil, which causes \$121,000,000 damage per annum, is kept in check by a dozen species of ants which destroy over 50% of the larvae (Vosburgh 1941).

In Texas *Solenopsis germinata* alone is reputed to destroy a similar percentage of the weevil larvae. Morley (1939), in an interesting paper, has discussed the possibility

of using ants to control insect pests. He has shown that the method is worth considering. The difficulty in rearing colonies is a fairly serious objection to their use. If ants are to be used for biological control then the usual precautions should be taken. These precautions are those which must always be observed when any insect is being introduced into a new habitat. In addition Morley suggests that suitable species should also show these features:—

- (i) they should have large colonies;
- (ii) they should not be likely to become household pests;
- (iii) they should not tend myrmecophiles;
- (iv) they should be easy to capture when swarming.

The third condition is, I believe, the most important. Morley lists the species which might prove useful together with the pests they attack and the areas into which they might be introduced. The only modern use of ants in this way (the introduction of *Ectatomma tuberculatum* into Texas, in 1904, to control the cotton boll weevil) was a failure for as Wheeler (1910) showed an unsuitable species was used.

Ants have often been used very successfully to delouse clothes and the visitation of the visiting ants to houses in the tropics is regarded as a blessing, since in a few hours they clear the dwelling of all vermin including the hated termites. The delousing of clothes is due to the fact that the ants eat the lice. Hase (1942) has shown that this is not caused by the formic acid, so that formazin, essentially 25—27% formic acid, as a delousing agent has no basis. Also he showed that it does not kill the eggs and furthermore produces considerable irritation of the skin.

Ants have been used as food. Wallace records the eating of *Atta cephalotes* by natives in the Amazon Region who regarded the egg laden queens as delicacies (Burr 1938). Recently Mittra & Mittra (1943) have shown that the red ant, *Oecophylla smaragdina*, which is eaten both raw and baked in quantities by the natives of Chotanagpur has a high protein value when tested on rats. The pupae of ants, especially those of *Formica rufa*, have been sold as “ants’ eggs” and used as food for cage birds and fish. It was the extensive collection of these pupae in German forests which necessitated the protective law referred to above.

The formic acid produced by ants has been used for many purposes, being prescribed nearly a millenium ago by Hildegard of Bingen as a cure for neuroses (Burr 1938). The rationale was that the counter-irritation of the acid would distract the patient’s attention from his complaint, a treatment which is not dissimilar to some of those used to-day. For many years ants were the sole source of formic acid—now the basis of so many plastics—and extracts of them were constantly made. Most Pharmocopceas had tinctures of ants while many old chemistry books and even some modern ones describe the preparation of this acid as the distillation of an alcoholic extract of ants. Baths of extracts of ants were, according to Schenk (1852), used as a cure for gout and rheumatism. It is interesting to note that a German firm not long ago put up a preparation of bee stings as a cure for rheumatism. Latreille (1802 p. 143) mentions that ant extract was used in Sweden to give a taste of lemons to cream. I have heard of such an extract being used as vinegar. Ants have been used in surgery as clips to sew up the edges of a wound, the insects being allowed to bite and then the rest of their bodies being snipped off. Burr (1938) records such a case in Smyrna in 1895. *Atta cephalotes* is often so used in South America. Professor R. M. Gordon, of the Liverpool School of Tropical Medicine, has told me that his father saw this practice during the Boer war. In classical times ants were used to diagnose diabetes;

if they came to a sample of urine it contained sugar and the patient was therefore a diabetic.

Even in this country ants play some small part in the pollination of certain flowers. In the tropics they are very important in this regard. Posnette (1942) has shown recently that in the Gold Coast *Crematogaster* species pollinate 50% of the cocoa (*Theobroma leiocarpa*). Associated with low humidity in this region there is low pollination probably due to the inactivity of the ants in dry weather.

Ants are responsible for spreading certain plants whose seeds (myrmecochores) are specially attractive to them because of their oily appendages. Stager (1929 A) has shown that the ants eat only the elaiom the actual seed remaining undisturbed. *Messor* species, however, eat the whole seed. Sernander has found 80 such species in oak forests alone while he has estimated that one colony of *Formica rufa* can transport nearly 500 such seeds in a season. Forel (1928) has termed the relation between such plants and the ants syndiacony. Scott (1926) has recorded *Lasius niger* collecting seeds of *Chelidonium majus* and (1944) also those of Rosemary.

Ants also furnish the main diet of many birds, especially the prized game birds such as partridges which in nature feed to a great extent on these insects.

Fish also feed on ants which fall on the surface of the water. I have found ants in the stomachs of trout caught at all times of the year. I was rather puzzled by the number of worker ants found in these stomachs. One would not have thought that so many workers fell into rivers. It would seem that the trout are efficient in removing any insects which happen to fall on the water surface. The presence of winged forms in fish stomachs is more easily understood since during the nuptial flight many of the ants get lost on the surface of the water. I have calculated (O'Rourke 1946) that over 50 million winged forms were floating on the water in Roundstone Bay Connemara, after the great swarm of August 23rd, 1942. Wheeler (1910) records that the excrement of a tertiary fossil fish consisted mainly of the heads of ants. It is clear that fish have been eating ants for a long time.

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## DIE WIRKUNG VON SCHÄDLINGSBEKÄMPFUNGSMITTELN AUF RÄUBERISCHE SCHWEBFLIEGEN (Dipt. Syrphidae)

Von F. Schneider

Die letzten Jahre sind bekanntlich durch die Entwicklung neuartiger synthetischer Insektizide mit einem grossen Wirkungsbereich ausgezeichnet. Diese neuen Mittel bieten im allgemeinen grosse Vorteile, doch darf nicht verschwiegen werden, dass gelegentlich unbeabsichtigte Nebenwirkungen auftreten, welche mit einer Massenvernichtung nützlicher Insekten zusammenhängen. Nach wiederholter DDT-Anwendung in Obstpflanzungen können Spinnmilben (*Paratetranychus pilosus*) und Blutlänse (*Eriosoma lanigerum*) einen viel grössern Schaden anrichten als in benachbarten unbespritzten Parzellen. In der Schweiz kennen wir Fälle, wo mit einer derartigen Verlagerung im örtlichen Insektenbestand die Wirtschaftlichkeit einer Bekämpfungsmassnahme in Frage gestellt worden ist, weil der Ausfall an Nützlingen einen grössern Schaden bewirkte als durch die Spritzung selbst verhütet werden konnte. Zur Deutung solcher praktischer Erfahrungen und zur Vermeidung eines Leerlaufes im Pflanzenschutz ist es deshalb wünschenswert, die Reaktion der Nützlinge auf neuartige Insektizide kennen zu lernen.

Unter den Schwebfliegen gibt es zahlreiche Gattungen, deren Vertreter sich im Larvenstadium von Blattläusen ernähren und deshalb ausgesprochen nützlich sind. Die Fliegen selbst sind Blütenbesucher und leben von Blütenpollen und zuckerhaltigen Ausscheidungen von Pflanzen und saugenden Insekten. Die Laboratoriumszucht ist nicht sehr einfach, weil die Fliegen in Gefangenschaft kaum kopulieren. Für Versuchszwecke geht man am besten von im Freien gesammelten Weibchen aus. Man stutzt ihnen die Flügel und füttert sie mit lufttrockenem Haselpollen (*Corylus*) und Zuckerlösung. Eine Fliege legt mehrere Hundert Eier, die höchste bisher festgestellte Eizahl betrug bei *Lasiopticus seleniticus* 1404 Stück. Zur Auslösung einer normalen Ablage befruchteter Eier und als Larvennahrung kann man mit *Rhopalosiphoninus latysiphon* besetzte Kartoffelkeime verwenden.

Bei einer Beurteilung der Gefährdung von Schwebfliegen durch chemische Bekämpfungsmassnahmen müssen auch die Generationsverhältnisse bekannt sein (Abb. 1). Es gibt ausgesprochen polyvoltine Arten wie *Epistrophe balteata*, welche sich vom Frühjahr bis zum Herbst ständig weiter entwickeln und als Fliegen überwintern. Viele Arten sind nur im Frühjahr, zur Zeit der intensivsten Blattlausvermehrung und des Blütemaximums aktiv und verharren 9—10 Monate am Boden als Altlarven in Diapause (z. B. *Epistrophe bifasciata*). Daneben gibt es zahlreiche oligovoltine Uebergangsformen mit obligatorischer oder fakultativer Diapause (z. B. *Syrphus albostrigatus*, *Syrphus ribesii*). Die einzelnen biologischen Typen lassen sich zum Teil anhand der Grösse der Augenanlagen in den Altlarven auseinanderhalten (Schneider 1948).

Die Schwebfliegen können nun an verschiedenen Stellen ihres Entwicklungszyklus von chemischen Bekämpfungsmassnahmen getroffen werden. Von allen präimaginalen Stadien sind wohl die Eier am meisten exponiert, weil sie nicht selten äusserlich auf die ungeschützte Blattfläche oder an Triebspitzen abgelegt werden. Die ältern Larven sind eher in der Lage, sich im Innern gerollter Blätter der direkten Wirkung des Spritzmittels zu entziehen. Auch ist es denkbar, dass die am Boden monatelang ruhenden Diapauselarven von Spritzbrühen getroffen werden, und schliesslich läuft die Fliege

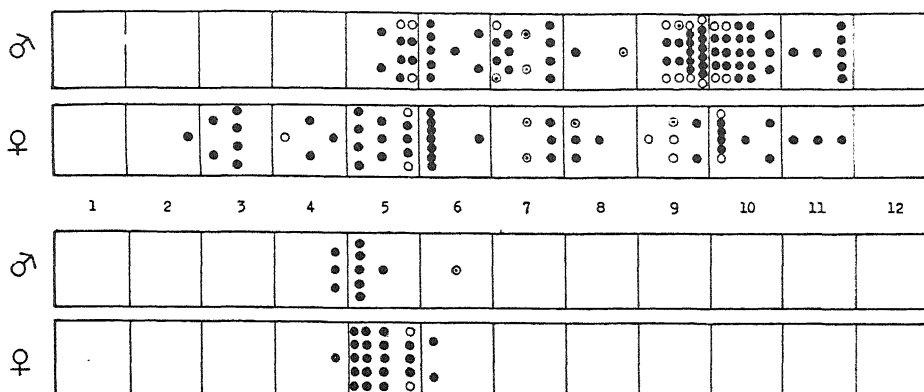


Abb. 1. Flugdiagramm von *Epistrophe balteata* (oben) und *E. bifasciata* (unten).  
Die Zahlen beziehen sich auf die Monate.

selbst Gefahr, bei der Eiablage oder auf der Suche nach Nahrung mit Frass- oder Kontaktgiften in Berührung zu kommen.

Unter Berücksichtigung dieser verschiedenen Vergiftungsmöglichkeiten wurden einige orientierende Laboratoriumsversuche durchgeführt. In der graphischen Darstellung (Abb. 2) ist die Mortalität (Höhe der Schraffur) verschieden alter Eier und Larven von *Lasioticus seleniticus* bei gründlicher Benetzung mit einigen gebräuchlichen Blattlaus-

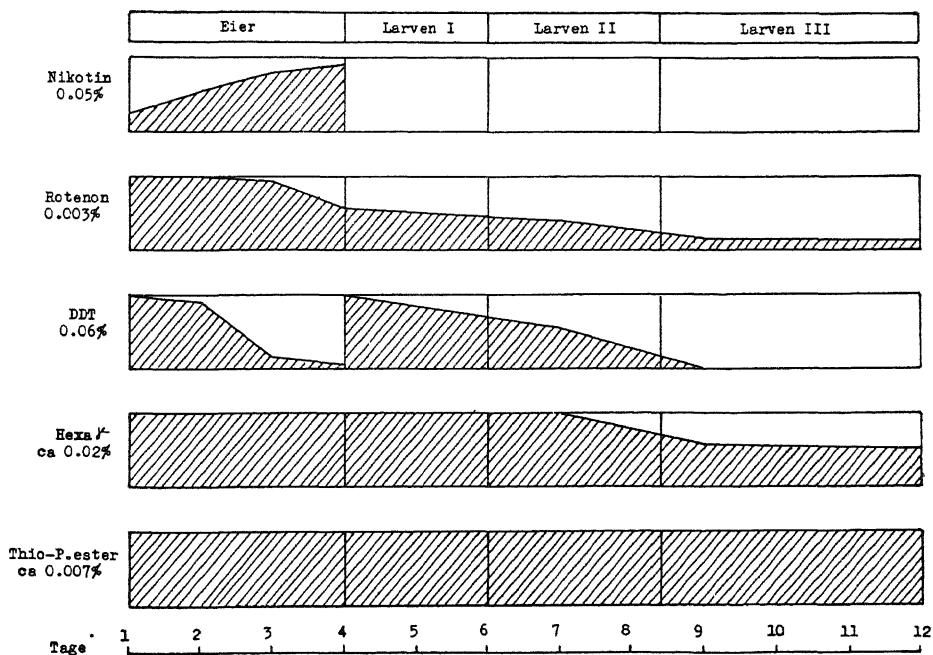


Abb. 2. Empfindlichkeit der verschiedenen Entwicklungsstadien von *Lasioticus seleniticus* auf Blattlausmittel. (Erklärung im Text.)

mitteln aufgetragen. Die Mittel wurden in der üblichen gegen Blattläuse wirksamen Konzentration angewendet. Der Wirkstoffgehalt der fertigen Brühen ist links angegeben. Das Versuchsmaterial wurde während einer Sekunde getaucht und ohne die überschüssige Flüssigkeit abzusaugen in ventilierte Zuchtbehälter übertragen. Es kamen je etwa 20 frisch abgelegte, 24 und 48 Stunden alte Eier zur Prüfung, ferner eine gleiche Anzahl Larven des ersten, zweiten und dritten Stadiums. Sie wurden als abgetötet taxiert, sobald sie nicht mehr schlüpften bzw. sich nicht mehr häuten oder das Puparium bilden konnten. Die Versuchstemperatur betrug 20—22° C.

Nikotin schädigt nur die Eier, wobei die Wirksamkeit des Giftes mit dem Alter eher zunimmt. Die Larven, auch die frisch geschlüpften, ertragen dagegen eine solche Behandlung, welche zur Abtötung der Blattläuse eben noch genügt. Beim rotenonhaltigen Spritzmittel werden bis auf die ältesten beinahe alle Eier abgetötet, und auch die jungen Larven erleiden eine Mortalität von 57—40 %. Die DDT-Emulsion vernichtet speziell die jungen Eier und Larven. Altlarven sind resistent. Durch die Hexa-Emulsion (Hexachlor-cyclohexan) wird bis auf 43 % der Altlarven alles abgetötet und der Thiophosphorsäureester (E 605 = Parathion) verschont offenbar nicht einmal die ältesten Stadien.

Als Ergänzung zu diesem Versuch bestimmten wir mit einigen Hundert 24 Stunden alten Eiern von *Epistrophe balteata* die letalen Grenzkonzentrationen von Nikotin und Thiophosphorsäureester bei 22° C, wobei nach dem Tauchen während 10 Sekunden die überschüssige Flüssigkeit mit Filtrierpapier sofort abgesaugt wurde. In beiden Fällen arbeiteten wir mit dem gleichen und gleichviel Netzmittel. Wir erhielten eine 50 %ige Mortalität (L.D.<sub>50</sub>-Wert) mit Lösungen von 0,5 % Nikotin und 0,0002 % Thiophosphorsäureester. Das letztere Insektizid ist demnach auf eintägigen Syrphideneiern etwa 2000 mal wirksamer als das Nervengift Nikotin.

Aus diesen Versuchen ist ersichtlich, dass in bezug auf Nützlingsschonung ausgehend von Nikotin über Rotenon, DDT, Hexa bis zum Thiophosphorsäureester kein Fortschritt erzielt worden ist. Während Nikotin selektiv den Schädling abtötet und den Nützling mehr oder weniger verschont, vernichtet der Thiophosphorsäureester beide Insekten radikal. Auf diese selektive Wirkung des Nikotins und die sich daraus ergebenden praktischen Konsequenzen ist auch schon früher von andern Autoren hingewiesen worden (z. B. Ripper 1944).

Die Wirksamkeit verschiedener, im Obstbau gebräuchlicher Spritzmittel auf Diapauselarven von *Syrphus melanostomoides*, *Epistrophe bifasciata* und *Epistrophe euchroma* ist tabellarisch dargestellt. Je 45 Larven wurden Mitte März auf einen Objektträger gelegt und bei 20° C mit den Spritzbrühen übergossen. Nach dem Abtropfen gelangte das Material zur Ausschliessung einer eventuellen Gaswirkung in grosse, gut ventilierte Zuchtbehälter. Zur Charakterisierung der einzelnen Mitteltypen ist die Anwendungskonzentration und der Wirkstoffgehalt angegeben, wobei betont werden muss, dass hier wie im ersten Versuch die Wirksamkeit nicht nur vom Wirkstoffgehalt, sondern auch von der Menge und Qualität der Netzmittel, Emulgatoren usw. abhängt.

Unwirksam sind Bleiarsen, Schwefelkalkbrühe, DDT-Suspensionen und -Emulsionen sowie Tetraäthylpyrophosphat. Auch ein speziell zur Bekämpfung der San José-Schildlaus und der Spinnmilben bewilligtes Gelböl (6) ist nur wenig wirksam, Nikotin ergibt im Gegensatz zum ersten Versuch in doppelter Konzentration bei diesen ruhenden Diapauselarven schon eine Mortalität von 72 %, Hexa-Präparate 88 und 94 %.

Wirkung gebräuchlicher Obstbaumspritzmittel auf Diapauselarven von *Syrphus melanostomoides*.

(ähnliche Resultate mit *Epistrophe bifasciata* und *Epistrophe euchroma*)

No.	Mitteltyp	Anwendungs- konzentration ‰	Wirkstoff- gehalt ‰	Wirksamkeit ‰
1	Bleiarzen	1	0.08 As	0
2	Schwefelkalkbrühe	1.5	32°Bé	0
3	DDT-Suspension	1	0.1	0
4	DDT-Emulsion	0.5	0.1	0
5	Tetraäthylpyrophosphat	0.03	0.03	0
6	Mineralöl-Dinitrokresol	3	2,3/0.15	30
7	Karbolineum normal	4	3	44
8	Rotenon	0.3	0.003	51
9	Nikotin	0.5	0.1	72
10	Mineralöl	3	2.4	77
11	Dinitrokresol	1.5	0.3	83
12	Karbolineum emulgiert	6	3.3	88
13	Hexa-Suspension	1	ca 0.016	88
14	Hexa-Emulsion	1	ca 0.02	94
15	Thiophosphorsäureester	10.0	ca 0.007	100

Der Thiophosphorsäureester steht trotz der hohen Verdünnung auch hier an der Spitze und tötet die Larven 100 ‰ig.

Schliesslich wurde noch die Reaktion der Fliegen selbst auf DDT-Beläge untersucht. Lässt man 3 Tage alte weibliche Fliegen von *Epistrophe balteata* im Schalenversuch bei 20° C 15 Sekunden bis 5 Minuten auf einem reinen, etwas aufgerauhten DDT-Belag laufen und überträgt sie darauf wieder in saubere Zuchtbehälter, so tritt beinahe unabhängig von der Einwirkungszeit nach 11 bis 21 Minuten durchschnittlich 15 Minuten Rückenlage ein. Die Tiere gehen nach stundenlang anhaltendem Tremor schliesslich zu Grunde. *Epistrophe balteata* reagiert demnach so rasch wie empfindliche Stämme von *Musca domestica*, für welche Wiesmann (1947) unter ähnlichen Versuchsbedingungen den Eintritt der Rückenlage nach 13 bis 18 durchschnittlich 16 Minuten angibt.

In einem vergleichenden Versuch wurden Männchen und Weibchen von *Epistrophe balteata* und *Musca domestica* bis zur Sättigung mit konzentriertem Zuckerwasser gefüttert und zur Entfernung anhaftender Zuckerreste an den Tarsen in einen Behälter mit nassem Filtrierpapier übertragen. Dann brachten wir die Tarsen der fixierten Tiere während 60 Sekunden in Kontakt mit einem aufgerauhten reinen DDT-Belag und reinigten die Berührungsstellen sofort wieder, indem wir sie mit Aceton auf Fliesspapier abtupften. Nach 20—30 Minuten traten bei allen *balteata* schwere Lähmungen auf, darauf folgte ein stundenlang anhaltender schwerer Tremor in Rückenlage, aus welchem sich etwa 50 ‰ wieder erholten. Bei *Musca domestica* reagierte 1/3 der Tiere überhaupt nicht, 1/3 zeigte reversible Lähmungen ohne Rückenlage und der Rest schwere irreversible Lähmungen. Bei zeitlich begrenztem Kontakt reagiert *E. balteata* demnach eher heftiger als *M. domestica*, doch ist *balteata* oft im Stande sich auch aus schwerem anhaltendem Tremor wieder zu erholen. Nebenbei mag festgehalten werden, dass bei geeigneter Versuchsanordnung auch *Musca domestica* schweizerischer Provenienz sich von leichten DDT-Lähmungen wieder erholen kann.

Die folgenden Versuche stellten wir bei 20° C mit Glasschalen an, welche mit einer normalen DDT-Suspension (0,2 ‰ Gesarol 50) gleichmässig ausgespritzt worden waren, was einer Wirkstoffmenge von 3,5 Gamma pro cm<sup>2</sup> entspricht. Weil Fliegen in gutem



Ernährungszustand einen DDT-Tremor leichter überstehen als Hungertiere, wurden alle Versuchstiere einige Stunden vor Versuchsbeginn mit konzentrierter Rohrzuckerlösung gesättigt und auf feuchtem Filtrierpapier gereinigt. Die Fliegen marschierten 30 Sekunden auf dem DDT-Belag. Dieser Test, bei welchem neben dem kurzen Kontakt noch das an den Tarsen hängen bleibende DDT zur Wirkung gelangt, entspricht ungefähr den natürlichen Freilandbedingungen. Bei dieser Versuchsanordnung sind folgende Arten abgetötet worden (in Klammern die Zahl der Versuchstiere):

*Syrphus albostrigatus* (1), *S. torvus* (2), *S. ribesii* (1), *S. vitripennis* (7), *Epistrophe balteata* (11), *E. grossulariae* (1), *E. triangulifera* (1), *E. cinctella* (2), *Ischyrosyrphus glaucius* (1), *Didea alneti* (1), *Sphaerophoria scripta* (22), *S. menthastri* (1), *Melanostoma mellinum* (10), *Pipiza* (1), *Musca domestica*, als Vergleich (6).

Einen reversiblen Tremor zeigten: *Syrphus ribesii* (4) und *Sphaerophoria scripta* (1), während in einigen Fällen eine Reaktion überhaupt ausblieb: *Syrphus ribesii* (6), *S. vitripennis* (3), *Epistrophe balteata* (1). *Syrphus ribesii* scheint verhältnismässig DDT-resistent zu sein.

Die meisten räuberischen Schwebfliegen werden demnach schon bei kurzem Kontakt mit einem normalen DDT-Belag abgetötet. Bei subletaler Dosis ist auch ein schwerer anhaltender Tremor in Rückenlage nicht selten reversibel. Diese Reversibilität lässt sich durch Lokalbehandlung eines Vorderfusses mit einer DDT-Lösung in Aceton jederzeit leicht reproduzieren (Schneider 1944). Sie scheint versuchstechnisch bedingt zu sein und tritt bei Kontakt mit normalen Spritzbelägen wohl seltener auf.

Die angeführten Versuche deuten darauf hin, dass sich die modernen Insektizide und die räuberischen Syrphiden schlecht vertragen, doch fällt es heute noch schwer, die praktischen Auswirkungen einer Massenvernichtung der Jugendstadien z. B. mit Thio-phosphorsäureester und der Fliegen z. B. mit DDT abzuschätzen. Die Folgen werden je nach örtlichen Verhältnissen verschieden sein, je nachdem diese Nützlinge bisher einen grösseren oder geringeren Beitrag zur Unterdrückung der Blattlausplage geleistet haben.

In regelmässig mit spezifischen Blattlausmitteln behandelten Anlagen wird der Ausfall der Nützlinge durch die verbesserte Wirksamkeit der chemischen Bekämpfungsmittel wohl meistens kompensiert werden können. Dagegen dürfte die Nachbarschaft behandelter Pflanzungen, wo keine spezielle Blattlausbekämpfung erfolgt, gelegentlich nachteilig beeinflusst werden. Bespritzte Flächen sind für Nützlinge steril, weil sie in Ermangelung geeigneter Wirte nichts zu deren Vermehrung beitragen, oder sie können für die gut fliegenden Eindringlinge und ihre Nachkommen sogar eine erhöhte Mortalität zur Folge haben. Damit sinkt jedoch die durchschnittliche Bevölkerungsdichte der Nützlinge einer ganzen Gegend und ihre Durchschlagskraft als biologische Regulatoren.

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## ZUR KENNNTNIS DER WIRKUNGSWEISE VON ORGANISCHEN PHOSPHORVERBINDUNGEN ALS INSEKTIZIDE

Von † H. Velbinger

### I. Einführung.

Als zu Beginn des letzten Krieges die ehemalige IG-Farbenindustrie (Elberfeld-Leverkusen) auf der Suche nach Nikotin-Ersatzstoffen in organischen Phosphorpräparaten ein hoch wirksames Spezifikum gegen Blattläuse auffinden konnte, da ahnte man kaum, dass hiermit der Auftakt zu einer ganz neuartigen chemotherapeutischen Entwicklung auf dem Gebiete der Pflanzenschutzforschung gegeben war (7). Dieser chemische Körper, der als BLADAN noch während des Krieges selbst in Amerika viel von sich reden machte, konnte von der IG (Elberfeld) in einer systematischen Kleinarbeit weiter entwickelt werden (8). Er führte nach dem Kriege zu etwa 600 völlig neuen chemischen Verbindungen, die aber teils zu giftig waren, wie z. B. E 600, oder keine überragende insektizide Wirkung erkennen liessen. Erst im Jahre 1945 kam in der Weiterführung dieser Verbindungen das Präparat E 605 auf, das jedoch erst etwas später seine heutige Struktur erhielt.

Etwa zu gleicher Zeit wurde durch die deutschen Chemiker H. Müller und H. J. Friedrich der Chem. Fabriken Gebr. Borchers A. G. in dem Werk Oker/Harz eine völlig andere Phosphorverbindung geschaffen, die als Xanthogenyl-*o*,*S*-Diäthylphosphorsäure Ester („POX“) eine bisher nicht erreichte insektizide Spontanreaktion entfaltete, ohne allerdings die chemische Stabilität von E 605 zu erreichen. Aus diesem chemischen Wirkstoff POX konnte sodann ein Körper entwickelt werden, der neben der hohen Initialtoxizität auch eine erheblich länger anhaltende Wirkung offenbarte. Dieser xanthobensaure Ester der *o*,*o*-Diäthylphosphorsäure zeigte aber wie die eben genannte *o*,*S*-Verbindung in den mehrjährigen biologischen Versuchen eine zu starke Verbrennung an Pflanzen.

Bei der Untersuchung verschiedener Phosphorsäureester auf insektizide Wirksamkeit ist in eben demselben Werk von H. Reisener das Ester der Monothiopyrophosphorsäure und der Dithiopyrophosphorsäure als Insektizide entdeckt und hergestellt worden. Unabhängig von all diesen Arbeiten konnte hier etwa zu gleicher Zeit in dem Präparat „T 47-Borchers“ der Wirkstoff Diäthyl-*p*-nitrophenyl-monothiophosphat erkannt werden, der, wie sich später herausstellte, chemisch mit E 605 identisch war. Im vergangenen Jahre wurde nunmehr dieser chemische Körper in Amerika unter dem Namen „Parathion“ bekannt und als „THIOPHOS-3422“ von der American Cyanamid Co. — New York herausgebracht (5).

Im Frühjahr 1947 kam sodann in Elberfeld-Leverkusen (Bayer) als Weiterentwicklung von E 605 nach eingehender Untersuchung zahlreicher neuer Stoffe das Präparat E 838 auf, das sich als hervorragendes Spezifikum gegen den Kartoffelkäfer erwies (9 u. 12). Es ist nicht ausgeschlossen, dass in absehbarer Zeit durch Auffindung neuartiger Stoffe der organischen Phosphor-Verbindungen die eben genannten Verbindungen wieder in den Schatten gestellt werden.

Wenn nun das Studium der organischen Phosphorverbindungen in der Erforschung der Wechselbeziehung von Konstitution und Wirkung sowie in der toxikologischen Fundierung von der gleichen Gründlichkeit durchdrungen ist, wie sie zur Lösung zahl-

reicher DDT-Probleme geführt hat, dann dürfte ein neuer Weg auf dem Gebiete der Pflanzenschutzforschung und Schädlingsbekämpfung gezeichnet sein.

## II. *Material und Methodik.*

Für die Untersuchungen zur Kenntnis der Wirkungsweise von insektiziden organischen Phosphorverbindungen fanden die Präparate BLADAN (Bayer), POX-1207 (Borchers), POX-Neu (Borchers), E 605 (Bayer), „1047“ (Bayer) und „T-47-Borchers“ Anwendung (E 605 und T 47 im folgenden kurz als „E-T“ bezeichnet).

Die biologischen Versuche zwecks Prüfung der insektiziden und physikalischen Eigenschaften wurden im Labor mit Hilfe der Lang-Welte'schen Dosierungsglocke (200 mg = 50 kg/ha) im Gewächshaus sowie im Freiland durchgeführt.

Zur Feststellung der Toxizität dienten 8 verschiedene Arten von Warmblütern.

Die Verträglichkeit des „E-T“-Wirkstoffes für Menschen konnte in mehreren Versuchsreihen bei einer Versuchsperson (H. B.) und am eigenen Organismus (H. V.) ermittelt werden.

In jedem Falle ist zur Bestimmung der Dosis tolerata, toxika und letalis der reine ölige oder in Lebertran gelöste Wirkstoff verabreicht worden.

Die Prüfung der Reaktionen im objektiven Vergiftungsbild erfolgte zum Nachweis der Beeinflussung des Grundumsatzes mit Hilfe des Knipping'schen Apparates.

Der Blutzuckerspiegel wurde im Tier- und Eigenversuch nach der Methode Crecelius-Seifert im nüchternen Zustand vor und nach der Wirkstoff-Applikation errechnet.

Die Leberfunktionsprüfung fand nach der Methode Takata-ara statt. In den Hauptversuchen ist vorliegende Arbeit im April 1948 zum Abschluss gebracht worden.\*

## III. *Chemo-physikalische Eigenschaften.*

1. *Bladan.* Dieser „Hexaäthylester der Tetraphosphorsäure  $(C_2H_5O)_2PO_3 \cdot PO_3$ “ (7) wird durch Einwirkung von 1 Mol Phosphoroxychlorid  $POCl_3$  mit 3 Molen Triäthylorthophosphat bei Gegenwart eines geringen Überschusses der letzteren Verbindung hergestellt. Das Reaktionsprodukt ist eine leichte, bernsteinfarbene, hygroskopische Flüssigkeit, die sich vollkommen in Wasser und in zahlreichen organischen Lösungsmitteln wie z. B. Aceton, Alkohol, Äther, Tetrachlorkohlenstoff, Xylol u. a. löst.

Amerikanische Forscher haben nun vor ganz kurzer Zeit gefunden, dass Hexaäthyl-tetraphosphat kein einheitlicher Körper ist, sondern eine Mischung darstellt von Tetraäthyl-pyrophosphat, Äthylmetaphosphat, Triäthyl-orthophosphat und wahrscheinlich Pentaäthyl-triphosphat (4). Hall und Jacobson (4) erkannten, dass Tetraäthylpyrophosphat der insektizid wirksame Bestandteil des sogenannten Hexaäthyl-tetraphosphates ist.

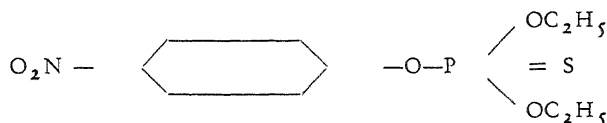
Der hoch toxische Bladan-Wirkstoff, der bei uns zu 70 % und in USA zu 50 % in der Stammlösung der Handelsprodukte enthalten ist, hydrolysiert schnell bei normaler Temperatur und Feuchtigkeit. Er bildet so relativ ungiftige Produkte, Diäthyl- und Monoäthyl-orthophosphorsäuren. Diese Hydrolyse-Produkte zeigen auch keine insektizide Wirksamkeit.

Schwerwiegende Blattverbrennungen sind auch in unseren Versuchen im allgemeinen — ausgenommen von Chrysanthemen und Tomaten (6) — bei einer Anwen-

\* Für die tatkräftige Unterstützung und die wertvollen Anregungen schulde ich besonderen Dank Herrn Dr. H. Reiserer, Herrn Gerhard Weidehase und Frä. Ursel Kischke.

dungskonzentration von 0.1 % nicht aufgetreten. Mit Schwefel- oder Kupferkalkbrühe soll sich Bladan nicht mischen lassen.

2. POX (*M 1207*) ist ein xanthogensaurer Ester der O,S-Diäthyl-phosphorsäure; der Körper ist wenig stabil.
3. POX-*Neu* ist ein xanthogensaurer Ester der O,O-Diäthyl-phosphorsäure. Hier ist also ein Schwefel durch einen Sauerstoff ersetzt worden. Der Körper ist bedeutend stabiler als POX, verbrennt aber erheblich die Pflanzen (Xanthogenat!).
4. *E 605/T 47*. Dieser Monoaryl-Dialkyl-Ester der Thiophosphorsäure hat die Formel



Der reine Wirkstoff ist eine gelbe bis braune ölige Flüssigkeit, der ein wahrnehmbarer Phosphingeruch und ein scharfer, bitterer Geschmack eigen ist.

Der Siedepunkt soll bei 3750 C liegen (5) und die spezifische Dichte 1,26 betragen.

Der „E-T“-Wirkstoff löst sich recht gut in animalischen und vegetabilen Ölen sowie in einigen organischen Lösungsmitteln wie Aceton, Äthyläther, Cyclohexan oder Alkoholen. Er ist schwer löslich in Wasser, Petroläther, Kerosen und „raffinierten Spray-Ölen“. Weiterhin soll der Wirkstoff unter normalen Bedingungen gegen Hydrolyse stabil und durch Oxydation nicht leicht zu zerstören sein. Es ist bemerkenswert, dass nach kurzfristiger Einwirkung höherer Temperaturen die Toxizität des Wirkstoffes zunimmt (13).

Die Behandlung mit *E 605*-Staub zeigte bei einer durchschnittlichen Temperatur von 23° C und einer relativen Luftfeuchtigkeit von 70 % keinerlei Verbrennungserscheinungen an ausgewachsenen Topfpflanzen wie z. B. Fuchsia, Begonia, Pelargonium, Tradescantia, Cyclamen, Chrysanthemum, Dahlia und Asparagus. Im Tauchverfahren liess die Emulsion (*E 605* = 74 % Wirkstoff) in 0.01—0.05 % keine Verbrennungen, wohl aber bei 0.1 % Blattveränderungen an Asparagus und Fuchsia erkennen.

Das Spritzmittel *T 47* (= 5 % Wirkstoff) verursachte in 0.1 %iger Konzentration weder im Gewächshaus- noch im Freilandversuch irgendwelche ungünstige Nebenerscheinungen.

Der Umstand, dass die „E-T“-Emulsion auf Grund ihrer respiratorischen Eigenschaft und ihrer — wenn auch nur geringen — Wasserlöslichkeit bei der Behandlung von Pflanzen in das Innere des Blattes oder der Frucht einzudringen vermag, lässt weitgehende Rückschlüsse auf die Anwendungsbreite und Wirkungsstärke des Mittels zu. Nach Entfaltung seiner Wirksamkeit war in unseren Versuchen *T 47* nach 12 Stunden nicht mehr im Apfelfruchtfleisch biologisch nachzuweisen.

#### IV. Insektizide Wirkung.

1. *Wirkungsform*. Abgesehen von der unterschiedlichen Wirkungsstärke sind in insektizider Hinsicht innerhalb der organischen Phosphorverbindungen beachtliche Unterschiede in der Wirkungsform festzustellen. Während *E 605* und *T 47* eine Wirkungsbreite haben, die diejenige der DDT- und Gammexan-Präparate übertreffen, wirken *E 838* und Bladan vor allem gegen Kartoffelkäfer und Blattläuse, womit allerdings nicht gesagt sein soll, dass hiermit auf andere Insekten keinerlei Wirkung nachzuweisen wäre.

In der Schnelligkeit der Intoxikation, der sogenannten Latenzphase, tritt in der Erscheinungsform der Reaktion der Unterschied zwischen der Xanthogenatverbindung der O,S-Diäthyl-phosphorsäure (POX, M 1207) und den „E-T“-Präparaten besonders offensichtlich hervor. POX wirkt als Cerebrospinalgift so spontan, wie bisher von keinem anderen Mittel erreicht wurde. Die Wirkung lässt aber im Gegensatz zu „E-T“ schon nach 1—2 Tagen nach. Erheblich stabiler verhält sich die Xanthogenatverbindung der O,O-Diäthylphosphorsäure (POX-Neu), die in der insektiziden Reaktion POX noch übertrifft. Die anhaltendste Wirkung war im Freilandversuch nach 10 Tagen bei E 605 und T 47 aufzuzeichnen.

Ablauf und Entwicklung der Reaktion verraten in der Exzitationsphase ad exitum trotz der unterschiedlichen, chemischen Konstitution von POX-Neu und T 47 doch einen gewissen Gleichklang.

Vergleichen wir allgemein die Wirkungsform der neuzeitlichen Insektizide miteinander, dann kann mit Sicherheit gesagt werden, dass von der kritischen Schwelle an beim Übergang von der Exzitations- zur Anästesiophase bei den POX- und „E-T“-Stoffen die charakteristischen Symptome der Intoxikation oft überdeckt werden und schneller folgen als z. B. bei den chlorierten Kohlenwasserstoffen, DDT und Gammexan. So sind auch bei den oben genannten Phosphorverbindungen kaum in dem Masse die Tremorerscheinungen festzustellen wie bei DDT.

Versuche ich, den Unterschied in der Reaktionsform zu schematisieren, dann ergibt sich, dass

- a) die DDT-Reaktion spät einsetzt und lang anhält,
  - b) die Gammexan-Reaktion spontan erfolgt,
  - c) die „E-T“-Reaktion etwas später, aber dann intensiver eintritt, und dass
  - d) die POX-Reaktion spontan beginnt und schnell abläuft.
2. *Wirkungsstärke und -breite.* Zweifellos sind die „E-T“-Produkte im allgemeinen allen anderen insektiziden Insektenberührungsgiften überlegen. In meinen mehrjährigen Untersuchungen (13) haben E 605 und T 47 gegenüber DDT und Gammexan eine beständigere und vielseitigere Wirkung entfaltet. Besonders bewährten sie sich gegen Drahtwürmer (*Agriotes lineatus*), Kornkäfer (*Calandra granaria*), Kiefernspinner-Raupen (*Dendrolimus pini*), Kohlweissling-Raupen (*Pieris brassicae* und *P. rapae*), Hundelaus (*Haemotopinus piliferus*), Maikäfer und Engerlinge (*Melolontha vulgaris*), Mehlwürmer (*Tenebrio molitor*), Bettwanze (*Cimex lectularius*) und zahlreiche Blattlausarten wie *Hyalopterus*, *Myzus* und *Doralis*, oder Milben der Gattung *Paratetranychus*, *Sarcoptes*, *Chorioptes*, *Psoroptes* und *Demodex*. Auch die Sägewespen (*Hoplocampa spec.*), die Obstmade (*Carpocapsa pomonella*) und die San José-Schildlaus, die grössten Feinde des Obstbaues, lassen sich nach Sy (10) und Thiem (11) mit den E-Präparaten sicher bekämpfen.

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# BEITRAG ZUR BIOLOGIE UND BEKÄMPFUNG DER „APFELFRUCHT- STECHER“ *Rhynchites aequatus* L. UND *Rhynchites* *bacchus* L.<sup>1)</sup> (Col. Curcul.)

(Aus der Entomol. Abt. des Pflanzenschutzinstitutes im Kgl. Bulg.  
Agr. Ministerium)

Von † *Helmut H. Velbinger*

## Einführung.

Die „Apfelbruchstecher“ *Rhynchites aequatus* L. und *Rh. bacchus* L. haben schon seit jeher in zahlreichen europäischen Obstanlagen dem Obstbauer schwer zu schaffen gemacht. Besonders im Südost-Raum unseres Kontinents, in Jugoslawien, Rumänien und Bulgarien erreichte der Befall in den letzten Jahren stellenweise geradezu katastrophale Ausmasse. Der von den Fruchtstechern angerichtete Schaden belief sich allein in Bulgarien 1942 auf mehrere Millionen Reichsmark und zeigte nicht nur qualitativ (Abb. 7 B), sondern auch mengenmässig auf dem Innenmarkt wie im Exporthandel schwerste Verluste. Mehrere grössere Obstplantagen schienen dem Untergang geweiht zu sein, und wirtschaftspolitisch traten im Gütertausch als unmittelbare Folge hiervon erhebliche Stockungen ein. In den von mir und meinen Mitarbeitern in den Jahren 1942—1944 untersuchten 40 grösseren bulgarischen Obstpflanzungen (2000 ha) konnte nicht selten ein Befall von 60—80 % an Apfel, Aprikose, Kirsche und Zwetsche ermittelt werden (2). Ja, in vielen europäischen und asiatischen Obstländern ist die Verbreitung dieser Schädlinge zu einem ernsthaften Problem geworden. Im Wolga-Gebiet, in Nord- und Transkaukasien, in der Ukraine, auf der Krim, in Persien und Syrien sollen beide Stecher mit zu den gefährlichsten Obstschädlingen zählen. Im Süd-Westen, wie z. B. in Süd-Frankreich, Spanien, Sizilien und Algerien werden die Obstanlagen besonders von dem „Purpurroten Apfelstecher“ (*Rh. bacchus*) heimgesucht, während nach unseren bisherigen Ermittlungen in Deutschland z. B. in der Mark Brandenburg der „Rotbraune Apfelbruchstecher“ (*Rh. aequatus*) und dagegen in Sachsen oder der Vorderpfalz *Rh. bacchus* vorzuherrschen scheint.

## Beschreibung.

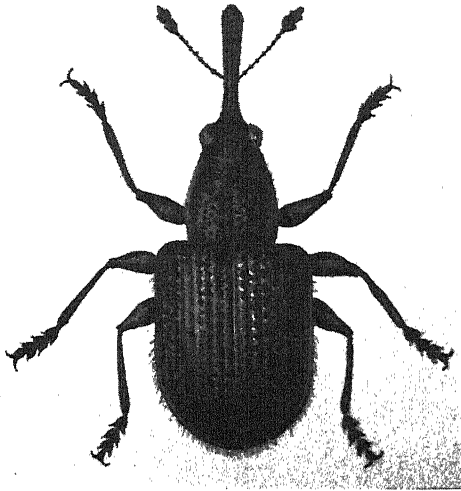
Diese 3—8 mm langen, braun- und weinroten Stecher erscheinen kurz vor dem Aufblühen der Obstbäume. *Rh. bacchus*<sup>2)</sup>, der eine Länge von nahezu 8 mm erreicht, zeigt in seiner Stammform eine purpur- bis weinrote und goldgrün glänzende Farbe und ist am ganzen Körper mit dichten, abstehenden Haaren bedeckt. Fühler, Rüssel und Beine schillern bläulich oder dunkelviolet (Abb. 2) und die Flügeldecken sind runzlig punktiert.

<sup>1)</sup> Die Untersuchungen wurden im Auftrag und mit Mitteln des Bulg. Agr. Ministeriums und des Deutschen Reichsforschungsrates im Pflanzenschutz — Institut Sofia sowie in dem Landwirtschaftlichen Institut Pasardschik (Süd-Bulgarien) durchgeführt.

Für die Überlassung eines Arbeitsplatzes und die vielseitige Unterstützung habe ich den Herren Direktoren Dr. J. Kowatschewski und Dipl. Agr. A. Christoff zu danken. Besonderen Dank schulde ich auch meinen Mitarbeitern, meiner Frau Irmgard Velbinger, Fräul. Stud.-Ass. Ursula Matthes und Herrn Georgi H-Detschew.

<sup>2)</sup> Synon.: *Rhynchites laetus* Germ., *Rh. purpureus* Deg., *Curculio bacchus* L. *Attelabus bacchus* Panz., *Involvulus bacchus* Schrank.

Im Gegensatz hierzu wirkt der kleinere *aequatus*<sup>3</sup> im Farbton matter. Die Flügeldecken sind hell- bis dunkelbraunrot, schwach behaart und sehr dicht in Reihen punktiert. Der Brustabschnitt scheint goldgelb und der Rüssel dunkel, während die Fühler und Beine bräunliche Farbe erkennen lassen (Abb. 1).



*Rhynchites aequatus* L.

Abb. 1.

Die Variationsbreite der Körper- bzw. Rüssellänge war, abgesehen von der Geschlechtsdifferenzierung, bei *aequatus* und auch bei der in dem Gebiet Plovdiv (Süd-Bulgarien) vorherrschenden aberratio coloris Paykulli Schilsky ausserordentlich gross. Die grössten ♀♀ (5,8—6,3 mm) erreichten nahezu die Länge von *bacchus*.

Bei günstigem Wetter können die Käfer längere Strecken im Fluge zurücklegen („Markierungsmethode“!). Proterandrie liess sich nur vereinzelt beobachten. Im allgemeinen war das Verhältnis der Geschlechter nahezu gleich.

Der Reifungsfrass der Käfer hält im Frühjahr etwa 4 Wochen an. Hierbei fallen ihnen vornehmlich die Blüten, Fruchtknoten und Laubblätter zum Opfer. Der Blattfrass unserer Stecher ist als „Reifungsfrass“ im Gegensatz zu dem „Brutfrass“ des Blattrippenstechers *Rhynchites pauxillus* Germ. nicht charakteristisch und kann von dem zahlreicher verwandter Arten wie *Anthonomus pomorum* L., *Rhynchites cupreus* L. oder *Rhynchites auratus* L. kaum unterschieden werden (Abb. 3).

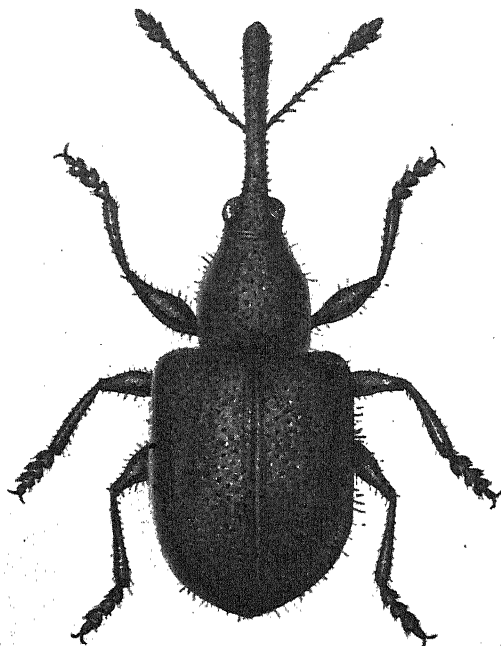
Sicherer ist dagegen die Bestimmung des Reifungsfrasses an den Früchten. Die „Apfel-fruchtstecher“ zeigen hier ohne Bevorzugung einer Stelle in der Mehrzahl der Fälle nur einen einfachen oder unregelmässig erweiterten Lochfrass, der bei *bacchus* zumeist und hin und wieder auch bei *aequatus* durch eine kragenartige, dünnhäutige Umrandung gekennzeichnet ist (Abb. 7 C).

Ganz anders tritt an den Früchten der Reifungsfrass des Birnenfruchtstechers *Rhynchites giganteus* oder des Kirschfruchtstechers *Rhynchites auratus* L. in Erscheinung,

<sup>3</sup> *Rhynchites purpureus* Goeze, *Rh. ruber* Geoffr., *Rh. bicolor* Rossi, *Rh. semiruber* Strl.



die häufig einen ausgedehnten „Platzfrass“ selbst unter Einbeziehung des Stieles erkennen lassen. Die Anzahl der *aequatus* — und *bacchus* — Einstiche an einer Frucht ist abhängig von dem Gesamtbefall des Baumes sowie von der Grösse und Beschaffenheit der Frucht. Es kommen Früchte mit 1 oder 2 Einstichen ebenso vor, wie mit mehr als 30 Einstichen (Tab. 2). Nicht selten konnten sogar völlig durchsiebte Früchte gesammelt werden (Abb. 7 D).



*Rhynchites bacchus* L.  
Abb. 2.

Es ist auffallend, dass, wie auch aus der Tabelle 2 zu ersehen ist, zur Zeit des Reifungsfrasses der Stiel der Früchte nur zu einem kleineren Teil angestochen wird, um die Frucht infolge Unterbrechung der Saftzufuhr am Baum mumifizieren zu lassen.

Die Kopula, die bis 80 Minuten dauern kann, findet gewöhnlich an schwülen Tagen, hin und wieder auch in warmen Dämmerungs- oder Nachtstunden statt und wird bei anhaltend günstiger Witterung etwa alle 2—4 Tage wiederholt.

Die Eiablage erfolgt bei sonnig warmem oder schwülem Wetter fast an allen Obstarten, vornehmlich jedoch an Apfel, Kirsche und Aprikose, ohne auffallende Sortenbevorzugung.

In einem „Selektionsversuch“ konnte der Nachweis erbracht werden, dass von *bacchus* die Obstfrüchte Aprikose, Apfel und Kirsche bevorzugt und Pfirsich und Zwetsche weniger belegt werden. Dagegen wurde an Birne, Quitte und Mispel selbst

in weichem und reifendem Zustand keine Eiablage festgestellt. Ähnlich verhielt sich in dem Versuch *aequatus*, der Apfel und Kirsche am stärksten belegte. Die Aprikose zeigte dagegen in der Fruchtwahl einen schwächeren Befall als die Quitte (Tab. 1). Im Zuge meiner epidemiologischen Untersuchungen in zahlreichen Obstpflanzungen des Balkans konnte dieses „Selektionsergebnis“ bestätigt werden. Der stärkste *aequatus*- und *bacchus*-Befall ist hier an Apfel, Kirsche, Aprikose und Zwetsche ermittelt worden, wogegen der Befall z. B. an Birnen so gut wie unbekannt ist (2).

Vor der Ablage bohrt der Käfer mit dem Rüssel ein Loch, dessen Tiefe von der Beschaffenheit der Frucht abhängt. Die Dauer des Bohrens währt 1—2 Min. Nach dem Herausziehen des oft bis an die Augen eingesenkten Rüssels dreht das Weibchen sich um 180° und drückt 1 oder 2 Eier mit der Hinterleibspitze in das Loch. Sodann schiebt nach einer abermaligen Drehung des Körpers der Rüssel in den meisten Fällen das Ei bis in den ausgeweiteten Lochgrund, um danach das Loch mit einer Fruchtfleisch-Sekretmischung (Mandibular-drüsen?) nach aussen zu verschmieren. Der Ort der Eiablage, Anstich und Eikanal sind bei *aequatus* und *bacchus* nahezu gleich. Nicht selten befinden sich in einer Frucht 4—8 Eier.

Nr.	Frucht	A n z a h l d e r						Bemerkungen
		unters. Früchte	E i e r insges.		A n s t i c h e i.Mittel/Frucht			
			a	b	a	b		
1	Apfel	20	31	22	9	17	Stielanstich!	
2	Birne	20	1	0	11	4	weiche u.harte Sort	
3	Zwetsche	20	2	9	4	5	sehr saftig!	
4	Kirsche	20	26	19	11	23	Stark,Stielanst.!	
5	Pfirsich	10	1	12	7	6		
6	Aprikose	20	6	62	23	90	1 Frucht 180 Anst.	
7	Quitte	20	9	0	19	2	harte Sorte!	
8	Mispel	20	0	0	0	2	halbreif!	

\* Sämtliche Früchte (Lokalorten), unreif am Zweig, zur Auswahl in je einen grossen Beobachtungswinger für *aequatus* und *bacchus* mit je 10 ♀♀ und 5 ♂♂ (gesammelt v. Apfelbaum!)

Die Grösse des meist länglich ovalen, gelblich-weissen, glänzenden *aequatus*-Eies beträgt im Mittel 0,51 × 0,79 mm, während das gedrungene *bacchus*-Ei im Durchschnitt 0,62 mm dick und 1,11 mm lang ist (Abb. 4). Als Abnormität fand ich in einem frischen Apfel ein *aequatus*-Ei von 1,08 mm Länge und 0,45 mm Dicke und in einer Aprikose ein schmales, zugespitztes *bacchus*-Ei, das ebenso unentwickelt blieb, wie die nicht glänzenden, matten Eier, die sehr bald vertrocknen. Die Variationsbreite der Eigrosse schwankt nicht immer mit der imaginalen Körperlänge. In den Balkanländern hält die Eiablage bis Anfang Juli an. Bis zu dieser Zeit können 50—80 Eier (nach B a l a c h o w s k y bis zu 230!) zur Ablage gelangen.

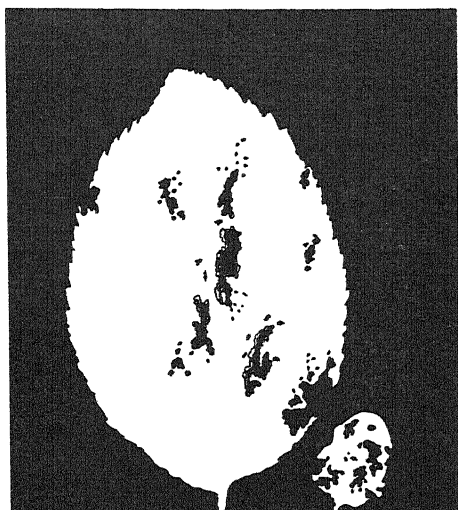
In den meisten Fällen bohrt das Weibchen neben den Eikanal noch einen zweiten Gang, der vermutlich das Austrocknen und die Pilzinfektion des Gewebes beschleunigen soll (15) (Tab. 2). Hiernach erfolgt zu dieser Zeit öfter doch recht willkürlich zur Unterbindung des Gewebesafte ein Annagen des Fruchstieles, so dass die befallene

Differenziertes Shadbild der von *aegatus* (ae) und *bacchus* (ba) befallenen Äpfel eines Baumes (Kanada — Renette).  
Tab. 2.

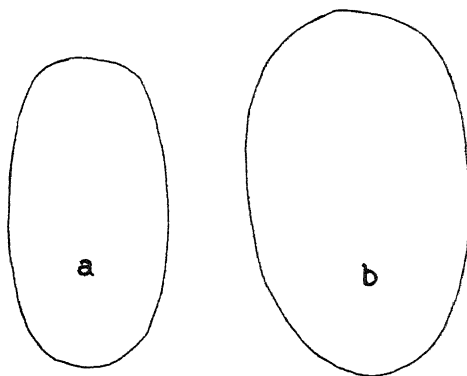
Apfel Nr.	Zahl d. Einstiche						Eiloch geschlossen	Zahl d. Eier		Bikanal		Platz- frass	Stiel- anstich	Monilia
	1-2	3-6	7-10	11-20	21-29	30-∞		ae	ba	einfach	doppelt			
1							3	—	—					
2							1	—	—					
3							0	—	—					
4							0	—	—					
5							1	—	—					
6							5	—	5					
7							4	2	—					
8							8	—	8					
9							5	1	—					
10							0	—	—					
11							0	—	—					
12							1	—	—					
13							2	—	2					
14							1	—	1					
15							5	—	5					
16							1	—	—					
17							0	—	—					
18							0	—	—					
19							2	—	1					
20							1	—	1					
21							4	—	2					
22							0	—	1					
23							1	—	1					
24							1	—	1					
25							1	—	—					
26							4	3	—					
27							1	—	—					
28							2	—	1					
29							0	—	—					
30							0	—	—					
31							0	—	—					
32							0	1	—					
33							0	—	—					
34							0	—	—					
35							0	—	—					
36							1	—	—					
37							1	—	1					
38							2	—	2					
39							3	1 Larv	—					
40							3	—	—					
41							1	—	—					
42							1	1 Larv	—					
43							2	1 Larv	—					
44							4	—	2					
45							4	2 Larv	—					

Frucht sich nur langsam entwickeln kann, allmählich vertrocknet, verholzt und mumifiziert („Baumfrucht“) oder zu Boden fällt („Bodenfrucht“).

Die Ei-Entwicklung dauert bei beiden Arten, je nach den Witterungsverhältnissen, 6—15 Tage (Tab. 3 u. 4), wobei die Beschaffenheit des Fruchtfleisches, die Sorte oder Art der Frucht ohne jeglichen Einfluss ist. Selbst auf einem trockenen Objektträger vermag sich das Ei normal weiterzuentwickeln. Das Temp.-Optimum liegt für die



*Aequatus* — Reifungsfrass an Apfel-Laub- u. Blütenblatt.  
Abb. 3.



*Aequatus* (a)- u. *bacchus* (b)-Ei etwa 50 fach.  
Abb. 4.

Entwicklung (6—8 Tage) im Mittel bei  $21,5^{\circ}\text{C}$ . Tieferere Temperaturen ( $12^{\circ}\text{C}$ ) zeigten sich, wie aus den Tabellen 3 u. 4 hervorgeht, im Versuch in gleicher Weise entwicklungshemmend, wie starke Kontrast-Temperaturen ( $15^{\circ}$ — $35^{\circ}\text{C}$ ).

*bacchus* — Entwicklung und Temperatur  
(Pasardschik — Bulgarien, Juli 1944)

Tabelle 3

Nr.	Frl.d. (Freiland)	Lab. (Labor.)	Frucht		Anzahl d. kontroll. Eier	Ø Temp. °C	Larve geschl. n. Tagen
			Ar.	Zustand			
1			Apfel	Monilia	3	7,1	11
2			Kirsche	Monilia	1	7,1	11
3			Apfel	frisch	1	10,3	12
4			Apfel	mumifiziert	1	10,3	12
5			Apfel	frisch	3	12,3	13
6			Apfel	Monilia	1	12,3	13
7			Kirsche	Monilia	2	12,3	13
8			Kirsche	trocken	1	13,1	13
9			Kirsche	verholzt	2	13,1	13
10			Apfel	vertrocknet	1	14,9	15
11			Apfel	vertrocknet	2	16,8	11
12			Kirsche	Monilia	1	17,5	12
13			Kirsche	Monilia	3	17,8	13
14		Lab.	Apfel	frisch	1	19,0	9
15		»	Apfel	Monilia	2	20,0	8
16	Frl.d.		Kirsche	Monilia	2	20,0	7
17	»		Apfel	frisch	2	20,0	7
18		Lab.	Kirsche	Monilia	1	20,7	7
19		»	Apfel	Monilia	1	20,8	6
20		»	Kirsche	vertrocknet	3	20,9	6
21		»	Kirsche	Monilia	1	21,1	8
22		»	Kirsche	Monilia	2	21,2	9
23		»	Kirsche	Monilia	2	21,4	8
24		»	Apfel	frisch	1	21,8	8
25	Frl.d.		Apfel	Monilia	7	22,7	6
26		Lab.	Kirsche	Monilia	7	22,7	6
27		»	Kirsche	frisch	1	22,7	6
28		»	Apfel	frisch	1	22,8	7
29	Frl.d.		Kirsche	Monilia	1	22,8	7
30		Lab.	Kirsche	Monilia	3	23,0	7
31		»	Apfel	vertrocknet	2	23,0	7
32		»	Apfel	frisch	1	23,0	7
33		Lab.	Apfel	frisch	5	24,2	11
34	Frl.d.		Apfel	frisch	3	25,0	13

*aequatus* — Eientwicklung und Temperatur  
(Pasardschik — Bulgarien, Juli 1944)

Tabelle 4

Nr.	Frid. (Freiland)	Lab. (Labor)	Frucht		Anzahl d. kontrol Eier	Ø Temp. ° C	Larve geschl. n. Tagen
			Art	Zustand			
1		Lab.	Apfel	vertrocknet	1	13,9	15
2		"	Apfel	vertrocknet	3	15,1	15
3	Frid.		Apfel	frisch	1	81,7	10
4			Apfel	frisch	2	22,7	8
5			Kirsche	frisch	2	22,7	6
6			Apfel	frisch	2	22,9	8
7			Kirsche	Monilia	1	22,9	8
8			Kirsche	trocken	1	22,9	8
9			Apfel	frisch	1	23,1	10
10			Kirsche	frisch	5	23,5	10
11			Apfel	frisch	1	23,6	10

*aequatus* und *bacchus* — Larven — Entwicklung im Übertragungsversuch  
an unbefallenen Früchten.

Pasardschik, Labor, 6. August 1944)

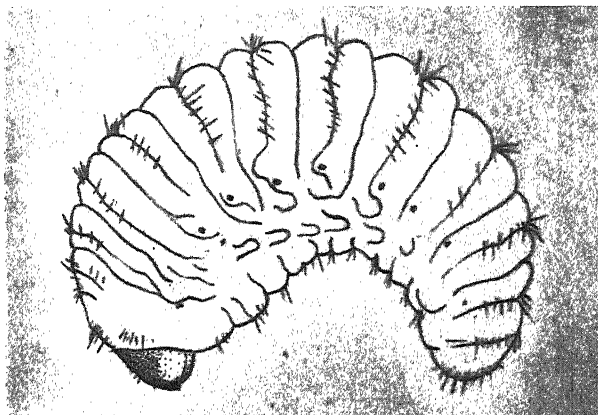
Tab. 5

Nr.	Sorte	Zustand d. Frucht a. Tag d. Übertrg.	Grösse d. Larve (mm Länge) a. Tag. d. Übertrg.	Grösse d. Larve (mm Länge) nach 8 Tagen	Standort d. Lar- ve 8 Tage n. Übertrg.
1	Kaiser Alexander	total Monilia sehr saftig	2,5	Frucht verlassen	—
2	Kasseler Renette	sehr saftig	2,0	Frucht verlassen	—
3	Kanada Renette	3/4 Monilia sehr saftig	2,9	Larve tot!	i. Miniergang
4	Kanada Renette	frisch gesund	3,0	4,2	i. Miniergang
5	Leder Renette	mumifiziert	3,8	5,9	a. Kerngehäuse
6	Leder Renette	total Monilia sehr saftig	3,5	Larve tot	i. Übertrgsgang
7	W. Goldparmäne	sehr saftig	3,1	Larve krank	i. Übertrgsgang
8	W. Winterkalvill	3/4 Monilia	2,3	3,2	i. Miniergang

Nr.	Sorte	Zustand d. Frucht a. Tag d. Übertrg.	Grösse d. Larve (mm Länge) a. Tag. d. Übertrg.	Grösse d. Larve (mm Länge) nach 8 Tagen	Standort d. Larve 8 Tage n. Übertrg.
9	Aiwanian	frisch gesund	3,8	5,0	a. Kerngehäuse
10	Apirosa	frisch gesund	4,2	6,0	i. Miniergang
11	Buchawitza	1/2 Monilia	4,0	5,5	i. Miniergang
12	Buchowka	3/4 Monilia	3,5	Larve tot	i. Miniergang
13	Dedowka	total Monilia sehr saftig	4,0	Larve tot	i. Miniergang
14	Kitschowka	1/2 Monilia	4,2	5,0	i. Miniergang
15	Samoraska	mumifiziert lederartig	3,2	5,9	i. Kerngehäuse
16	Skrinianka	mumifiziert lederartig	4,0	6,5	i. Kerngehäuse
17	Pastorenbirne	frisch gesund	4,5	Frucht verlassen	i. Kerngehäuse
18	Le lectier	frisch gesund	3,2	4,4	i. Miniergang
19	Winter-dechantsbirne	frisch gesund	3,8	Larve krank	i. Übertrgsgang
20	Wiener Triumph	1/2 Monilia	4,0	Larve krank	i. Übertrgsgang
21	Quitte	frisch gesund	3,5	Frucht verlassen	—
22	Mispel	frisch gesund	5,2	Larve krank	i. Übertrgsgang
23	Pfirsich	frisch gesund	3,0	4,2	i. Miniergang
24	Aprikose	frisch gesund	2,5	4,9	i. Miniergang
25	Zwetsche	frisch gesund	4,0	5,2	i. Miniergang
26	Kirschpflaume	frisch gesund	3,9	Frucht verlassen	---

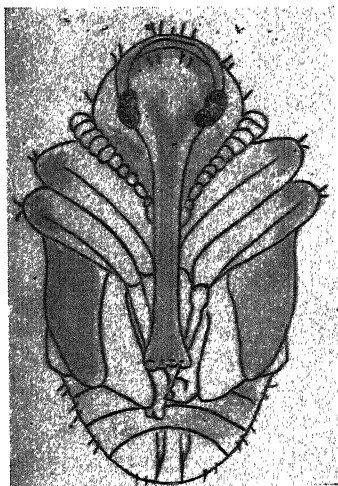
### Larven-Entwicklung.

Nach dem Schlüpfen aus der Eischale wandern die weisslichen, schwach beborsteten Larven (Abb. 5), die zur Entwicklung, falls sie nicht in der „Baumfrucht“ überwintern, etwa 5—10 Wochen benötigen, an oder in das Kerngehäuse. Sorte, Art und Beschaffenheit der Frucht bestimmen die Dauer der Entwicklung sowie Farbe und Glanz der Larven (Tab. 5). In lederartigen, mumifizierten Früchten ist die Entwicklung der Larven am günstigsten (Tab. 5, Nr. 5, 15 u. 16), während sich die Larven in sehr



*Rhynchites bacchus* — Larve (halb schem., etwa 15×).

saftigen, faulenden Früchten schlecht entwickeln, abwandern oder zu Grunde gehen (Tab. 5, Nr. 1—3, 6, 7, 12, 13 u. a.). Die Grösse und der Zustand der Larven (470 Larven gemessen!) sind in den ersten Wochen der Entwicklung sowohl in den am Baum hängenden („Baumfrüchte“) als auch in den zu Boden gefallen Früchten („Bodenfrüchte“) nahezu gleich. Später wachsen die Larven in den „Bodenfrüchten“ schneller und erreichen schon im Juli/August mit etwa 6,0 mm Länge und 2,5 mm Dicke das Endstadium (*bacchus*). Dass, wie in Rumänien beobachtet wurde, unter besonderen Voraussetzungen unmittelbar hiernach schon die Verpuppung einsetzt, kann nicht verallgemeinert werden (6). Zu dieser Zeit (August) sind in den „Baumfrüchten“ Larven fast sämtlicher Entwicklungszustände anzutreffen. Nach dem Ab-



*Rhynchites bacchus* — Puppe (halb schem. n. Knechtel).  
Abb. 6.



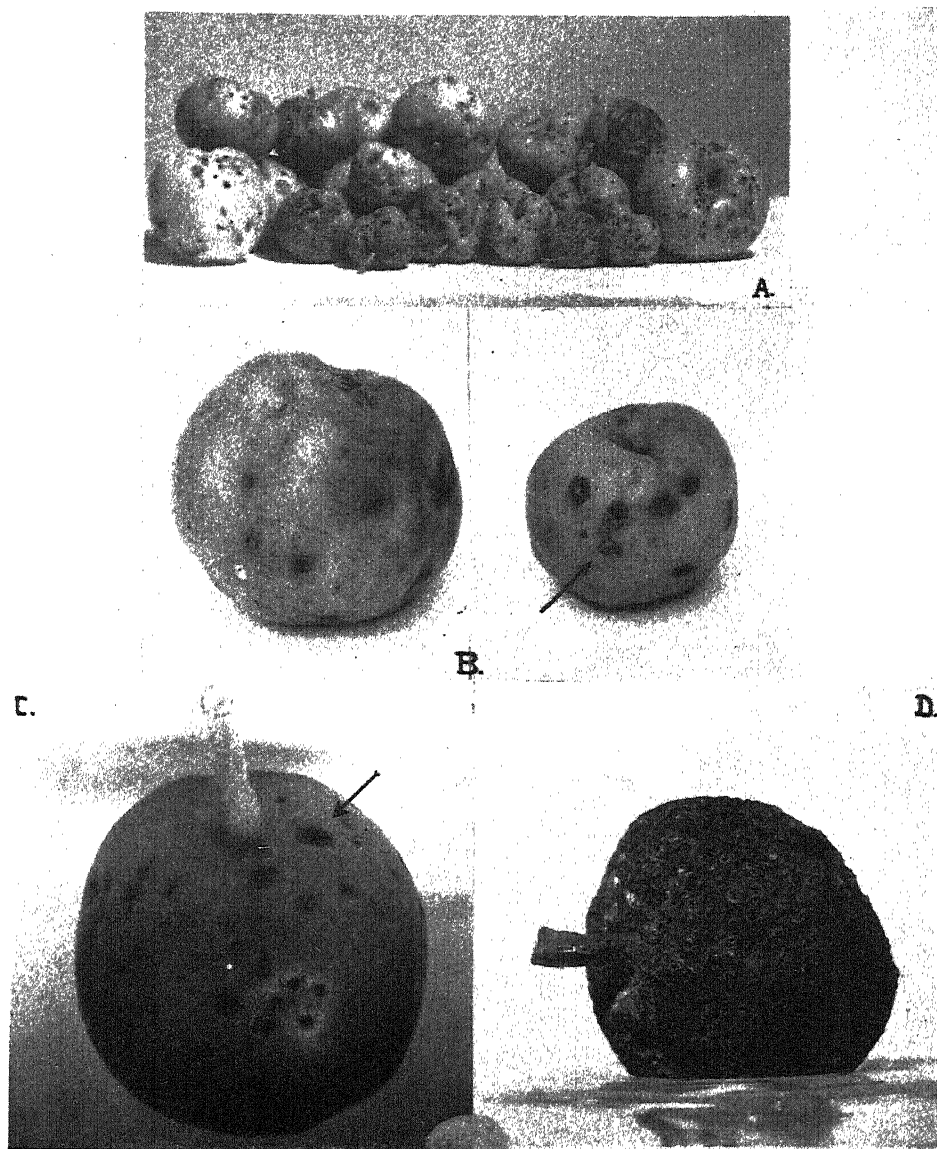


Abb. 7. Befall der Stecher an Apfel.

- A. Teilernte eines Zweiges (90 % Baumbefall), Bulgarien 1943.
- B. Verkrüppelte Früchte, Folgeerscheinung weniger Einstiche.  
(links: *aequatus*, rechts *bacchus*, ➔ „Platzfrass“).
- C. Einstiche und verschmierte Eilöcher (▼).
- D. Mumifizierte Frucht mit über 200 „Stichen“.

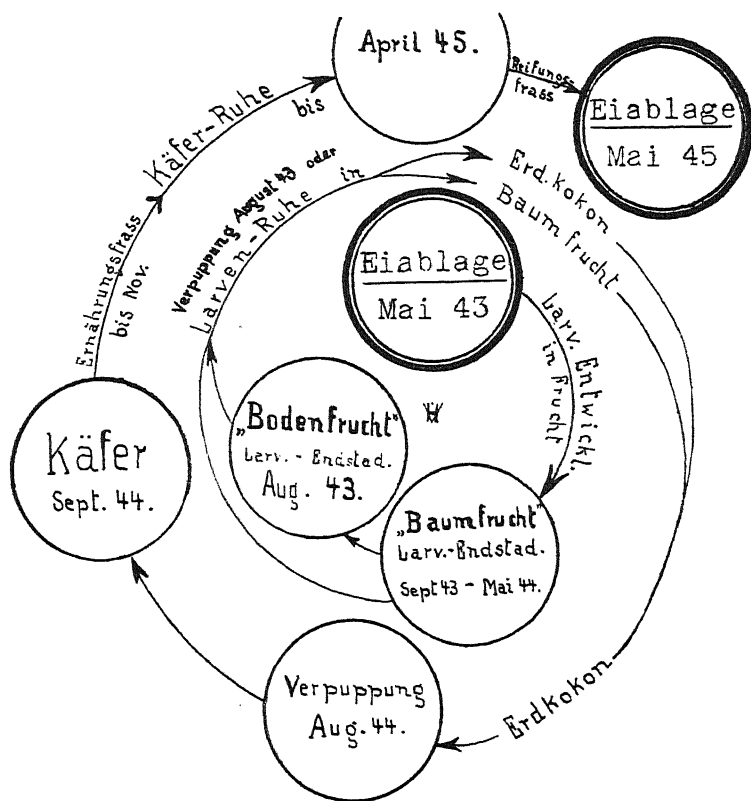
schluss der Frassperiode verlässt die vollentwickelte Larve die Frucht, um im Boden in einem ovalen bis kugelförmigen Erdkokon zu überwintern. Diese Larvenruhe kann mehr als ein Jahr anhalten. Die jüngeren Larven überwintern in den am Baum zurückbleibenden mumifizierten Früchten (Abb. 7 D).

Im Monat August des gleichen, in den meisten Fällen jedoch des folgenden Jahres findet im Boden (5—10 cm Tiefe) die *Verpuppung* (Abb. 6) statt. Die Käfer erscheinen im September, um nach einem bis in den November sich hinziehenden Ernährungsfrass in der Erde oder unter Blättern zu überwintern. Es überwintern somit Larve und Käfer derselben Generation. Nach 4—5 Monaten dürfte bei uns (Mittel-Europa) die Käferruhe abgeschlossen sein. Der gesamte Entwicklungszyklus der „Apfelbruchstecher“ dauert demnach im allgemeinen 2 Jahre (Abb. 8).

Die Lebensdauer beider Käfer beträgt im Freiland gebeutelt etwa 70—100 und im Labor 30—40 Tage. Markierte, freigelassene Käfer fand ich in meinen Freilandversuchen 1944 noch nach dem 45. Tag.

In der Wahl der Wirtspflanzen unterscheiden sich, wie schon gesagt, beide „Apfelbruchstecher“ nicht wesentlich. In Bulgarien konnten wir vor der Überwinterung der Käfer (Sept./kt.) an einigen wilden Obstarten und an der Mispel stellenweise

*Entwicklungs — Zyklus von Rhynchites aquatus u. Rb. bacchus.*



einen recht erheblichen Frass-Befall feststellen. Den ganzen Herbst über lassen sich starke Schäden an den Winterknospen ausmachen, die äusserlich eine gewisse Ähnlichkeit mit dem Frassbild des Birnenknospenstechers aufweisen.

Das Befallsbild im Herbst unterscheidet sich von dem während des Reifungsfrasses (April/Mai) an den Laub-, Kronen- und Kelchblättern sowie am Fruchtknoten erheblich. Die Grösse und Form des Einbohrloches sowie die Kanaltiefe hängt in erster Linie von der Frucht ab. Die Eilöcher sind bei *aequatus* öfter, bei *bacchus* dagegen fast immer (82 %) nach aussen verschlossen (Abb. 7 C). Als ein zweites Merkmal im Befallsbild kann der Platzfrass angesehen werden, der vom Einbohrloch oder Anstich aus in eine unregelmässige Ausweitung läuft und für *bacchus* an Apfel charakteristisch ist (Abb. 7 B). An Aprikose, Kirsche und Zwetsche tritt dieser Frass seltener in Erscheinung. Für *aequatus* ist im allgemeinen dieses nicht so kennzeichnend. Dagegen verursacht der „Goldgrüne Fruchtstecher“ *Rhynchites auratus* besonders an Kirsche ähnliche Spuren. Der Platzfrass kann, sofern es sich nur um einen oberflächlichen „Schabe-frass“ handelt, nach der Vernarbung im reifen Zustand der Frucht leicht mit *Fusicladium* verwechselt werden. Ein absolut sicheres Merkmal zur Differenzialdiagnose des Schadbildes lässt sich für die beiden Fruchtstecher nicht geben.

Als Folgeerscheinung der *aequatus*- und *bacchus*-Einstiche nimmt der reife Apfel oft eine krüppelige, deformierte Gestalt an (Abb. 7 B). Durch zahlreiche An- und Einstiche (bis 250 an einer Frucht!) wird je nach der Sorte oder Art der Frucht früher oder später der *Monilia*-Infektion (*Sclerotinia*) ein Weg gebahnt. Vermutlich infiziert der Käfer selbst auch die Frucht. Ob diesbezüglich ein Unterschied zwischen beiden Fruchtstechern wirklich besteht, lässt sich heute noch nicht mit Sicherheit sagen. Entgegen meiner früher geäusserten Darstellung (15) neige ich doch jetzt nach Prüfung von etwa 30 verschiedenen Apfelsorten zu der Annahme, dass der von mir und anderen Forschern beobachtete Unterschied zwischen beiden Stechern wohl mehr durch das verschiedenartige Verhalten des Fruchtfleisches bedingt ist (4, 5 u. 11). Auch *aequatus*-befallene Früchte wiesen in Süd-Bulgarien (Plovdiv, Pasardschik) recht erheblich *Monilia*-Infektion auf. Dass der Pilzinfektion eine gewisse Bedeutung für die Entwicklung der Larven beizumessen ist, dürfte feststehen. So handelt es sich hier vielleicht um eine „Symbiose zwischen Käfer und Pilz“ (6). Denn in nicht infizierten Früchten verlief im Versuch (Tab. 5) die Entwicklung keineswegs normal. Einige bulgarische Apfelsorten (*Samoraska*, *Dedowka* u. a.), die im isolierten Raum pilzfrei gehalten werden konnten, zeigten in mehreren Versuchen, dass die Beschaffenheit des „reinen“ Fruchtfleisches für die Larven entwicklungshemmend wirkte.

#### *Bekämpfungs-Massnahmen.*

Die Bekämpfung der Fruchtstecher war in kleinen Gartenanlagen bei Beachtung der vorgeschriebenen mechanischen Massnahmen schon immer recht erfolgreich. Hier erwiesen sich die von alters her überlieferten Methoden als die günstigsten:

1. Anlegen von Fanggürteln mit täglicher Kontrolle (Ende Sept.)
2. Abklopfen der Bäume im Herbst und Frühling (Okt. u. April)
3. Sammeln und Vernichten der „Bodenfrüchte“ (August/Sept.) sowie der mumifizierten „Baumfrüchte“ (Abb. 7 D) in den Wintermonaten.

In grossen Betrieben erwiesen sich allerdings diese Massnahmen wie auch bei der Bekämpfung der Blüten- und Knospenstecher als unzweckmässig und undurchführbar.

Auch die chemische Bekämpfung der Käfer mit Arsen-, Nikotin-, Derris- oder Pyrethrum-haltigen Mittel kann selbst nach mehrmaliger Behandlung keinen praktischen

Erfolg versprechen (Tab. 6). Der Grund hierfür dürfte vermutlich auch darin liegen, dass den polyphagen und anpassungsfähigen Käfern eine recht lange Zeitspanne für ihr Auftreten zur Verfügung steht. Eine ebenso geringe Bedeutung kommt der „Gelbspritzung“ (z. B. DETAL, SELINON, HERCYNIA-GELB) im Frühjahr zu. Dagegen lässt sich mit diesen kresolhaltigen Mitteln (*Dinitro-o-kresol*) im Oktober nach der Ernte eine recht erfolgreiche Bekämpfung erzielen.

Noch wirksamer ist die *Nachblüten-Spritzung* mit den neuen arsenfreien Kontaktpräparaten der chlorierten Kohlenwasserstoffe DDT (GESAROL) und Gammexan (VITON, NEXEN u. a.) sowie mit den organischen Phosphorpräparaten als Monoaryl-Dialkyl-Ester der Thiophosphorsäure (E 605, T 47, THIOPHOS).

Die *Frucht-Spritzung* ist dagegen aus naheliegenden Gründen nur mit DDT (GESAROL) durchzuführen.

M i t t e l	V e r s u c h s b ä u m e			Tag der		Zahl der Spritzg.
	Obstart	Anzahl	Befall in %		Behdlg. Kontr.	
QUASSIA - "Urania" 0,1% Zwetsche		15	42,0	69,0	5.V. 15.V.	1
Borchers						
HERCYNIA - NEUTRAL 0,4% Apfel		30	25,5	52,0	28.V. 10.VI.	1 (2)
Neudorff						
NIKOTIN-DERRIS 0,2% Kirsche		25	19,0	40,5	5.V. 15.V.	1
ROTENON - "Merck" 0,4% Apfel		10	12,0	31,0	9.V. 21.V.	1 (2)
Geigy A., Kl.						
GESAROL (DDT) 1,0% Zwetsche		100	2,0	41,0	5.V. 15.V.	1
.....		20	0,5	69,0	V/VI V/VI	3

In einer einmaligen GESAROL-Spritzung konnte 4 Tage nach Abfall der meisten Blütenblätter in einem Freiland-Grossversuch der *Rhynchites*-Befall an Apfel, Kirsche und Zwetsche (Assenowgrad 1943) von durchschnittlich 41,0 % auf 2,0 % herabgedrückt werden. Der Höchstbefall der nicht behandelten Obstbäume betrug 92,0 %. Nach dreimaliger Spritzung zeigten die unbehandelten Früchte einen *mittleren Befall von 69 %*, während die behandelten nur zu 0,5 % befallen waren. Da stets mit einem Neu-Anflug der Käfer gerechnet werden muss, ist eine 2. und bei sehr starkem Befall sogar eine 3. Spritzung im Abstand von 3—4 Wochen erforderlich (16).

Besonders schwierig gestaltet sich die Bekämpfung der „Apfelfruchtstecher“ in sogen. „Poikilo-Kulturen“, die mindestens einen 3-maligen Spritzgang mit einer gewissenhaft durchgeführten Kontrolle verlangen. Es ist zweckmässig, diesem Präparat noch ein wirksames Fungizid beizugeben.

Mit GESAROL (DDT) dürfte gleichzeitig eine erfolgreiche Bekämpfung gegen alle übrigen Stecher (*Byctiscus betulae* L., *Rhynchites pauxillus* Germ., *Rhynchites cupreus* L., *Rhynchites auratus* L. u. a.) voll und ganz gewährleistet sein.

#### Zusammenfassung.

- I. Epidemiologische und morphologische Hinweise
- II. Biologische Untersuchungen

1. Erscheinen der „Apfel-fruchtstecher“ kurz vor dem Aufblühen der Obstbäume.
2. Ei-Ablage nach der Kopula in zahlreiche Obstfrüchte.
  - a) Hierfür bevorzugt von *bacchus* Aprikose, Apfel und Kirsche und von *aequatus* Apfel und Kirsche.
  - b) „Ei-Loch“ in der Frucht mit einer Fruchtfleisch-Sekretmischung bei *aequatus* öfter und bei *bacchus* fast immer (82 %) nach aussen verschmiert.
  - c) Ort der Ei-Ablage, Anstich und Eikanal bei *aequatus* und *bacchus* nahezu gleich. In einer Frucht bis 8 Eier, von einem ♀ insgesamt 50—80 Eier.
3. Ei-Entwicklung bei beiden Arten 6—15 Tage. Das Temperatur-Optimum liegt für die Entwicklung (6—8 Tage) im Mittel bei 21,5° C.
4. Larven-Entwicklung

Die Larven benötigen 5—10 Wochen zur Entwicklung, deren Dauer von der Sorte, Art und Beschaffenheit der Frucht bestimmt wird. In lederartigen, mumifizierten Früchten ist die Entwicklung der Larven am günstigsten. Entwicklung in den „Boden-Früchten“ im allgemeinen kürzer als in den „Baum-Früchten“.

Larven-Überwinterung in den „Baumfrüchten“ oder in einem Erdkokon im Boden.

5. Verpuppung im August des gleichen oder des folgenden Jahres im Boden.
6. Käfer erscheinen im September und überwintern nach längerem Ernährungsfrass.

Es überwintern Larve und Käfer der gleichen Generation.

7. Der gesamte Entwicklungszyklus der „Apfel-fruchtstecher“ dauert im allgemeinen 2 Jahre.
8. Die Lebensdauer der Käfer im Freiland 70—100 und im Labor 30—40 Tage.
9. Befallsbild

Stielbefall öfter, doch recht willkürlich, zur Unterbindung des Gewebesafes Anstechen oder Annagen des Frucht-Stieles, sodass die befallene Frucht am Baum vertrocknet („Baumfrucht“) oder zu Boden fällt („Bodenfrucht“).

Für *bacchus* verschlossenes „Ei-Loch“ und Platzfrass charakteristisch.

Für beide Fruchtstecher kein absolut sicheres Merkmal zur Differenzialdiagnose des Schadbildes.

Wechselbeziehung zwischen *Rhynchites*-Schadbild und *Monilia*-Infektion.

### III. Bekämpfung

Zur Bekämpfung der „Apfel-fruchtstecher“ ist am günstigsten die GESA-ROL-Spritzung (DDT) 4 Tage nach Abfall der meisten Blütenblätter. In Freiland-Grossversuchen konnte nach 3-maliger Spritzung der mittlere Befall von 69 % auf 0,5 % herabgedrückt werden. Eine 2. oder 3. Spritzung ist bei starkem Befall im Abstand von etwa 3—4 Wochen erforderlich.

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## A PHYSICAL MECHANISM GOVERNING THE RATE OF PENETRATION OF CONTACT INSECTICIDES

By J. E. Webb

### *Insect Cuticle as a Two-phase System*

In an insect, the bulk of the cuticle comprises two layers, an inner endocuticle and a central exocuticle. The endocuticle is a laminated structure composed of a chitin-protein complex while the exocuticle is an apparently homogenous or structureless layer of chitin and protein associated with sclerotin. Both these layers are freely permeable to and are saturated with aqueous body fluid. The outermost layer of the cuticle lying beyond the exocuticle is the epicuticle, a complex structure which, according to Wigglesworth (1947), consists of an inner "cuticulin" layer probably consisting of polymerised lipoproteins tanned by quinones, followed by a layer rich in polyphenols upon which the innermost wax molecules are adsorbed and orientated to form the "wax layer" (see fig. 1). In some, but not all insects, the "wax layer" is covered by an outermost "cement layer" (Wigglesworth 1947 and Webb 1947). In *Rhodnius* and in the biting louse *Eomenacanthus stramineus* (see Webb 1947) at least, pore canals pass from the epidermal cells underlying the cuticle and penetrate the inner layers of the epicuticle or even as far as the wax layer and are filled with cytoplasmic contents. Dennell (1946), however, working with the larval cuticle of *Sarcophaga falcata*, found that only the outer zone of the endocuticle is penetrated by pore canals which stop short at the epicuticle and that the inner region of the endocuticle secreted later in larval-life contains no pore canals (there is no exocuticle in *S. falcata*). Furthermore, although the pore canals at first contain cytoplasmic filaments, these are later replaced by chitin.

In spite of the complexity and variety of structure to be found in the "external" cuticle of an insect, it is possible to greatly simplify the problem of the mode of penetration of contact insecticides through cuticle by considering the cuticle merely as a two-phase system comprising a thin wax layer lying upon a bulk aqueous phase, the exocuticle and endocuticle. If the wax on the cuticle of an insect is removed by abrasion with a hard dust such as carborundum or alumina or by solvent action, as can be demonstrated by the dark staining of the exposed underlying polyphenol layer with ammoniacal silver hydroxide (Wigglesworth 1945), then water evaporates from the abraded surface and continues to do so until the insect is completely desiccated. It may be concluded, therefore, that not only do the aqueous body fluids extend throughout the body and must be in contact with the base of the wax layer, but also they must be free to diffuse throughout the cuticle up to that layer. It may be assumed, therefore, that the cuticle of an insect is essentially a two-phase system of wax and water with a definite interface between the two layers. This conception does not imply that paths of lipid elements extending from the epidermal cells to the wax layer do not exist. Indeed it seems certain that they are present at least at some time during an insect's life. For instance, where the pore canals contain cytoplasmic contents then a lipid-containing plasma membrane will extend at least as far as the cuticulin layer of the epicuticle if not as far as the base of the wax. Wigglesworth (1945 and 1947) has shown that, even in the adult, repair of damaged

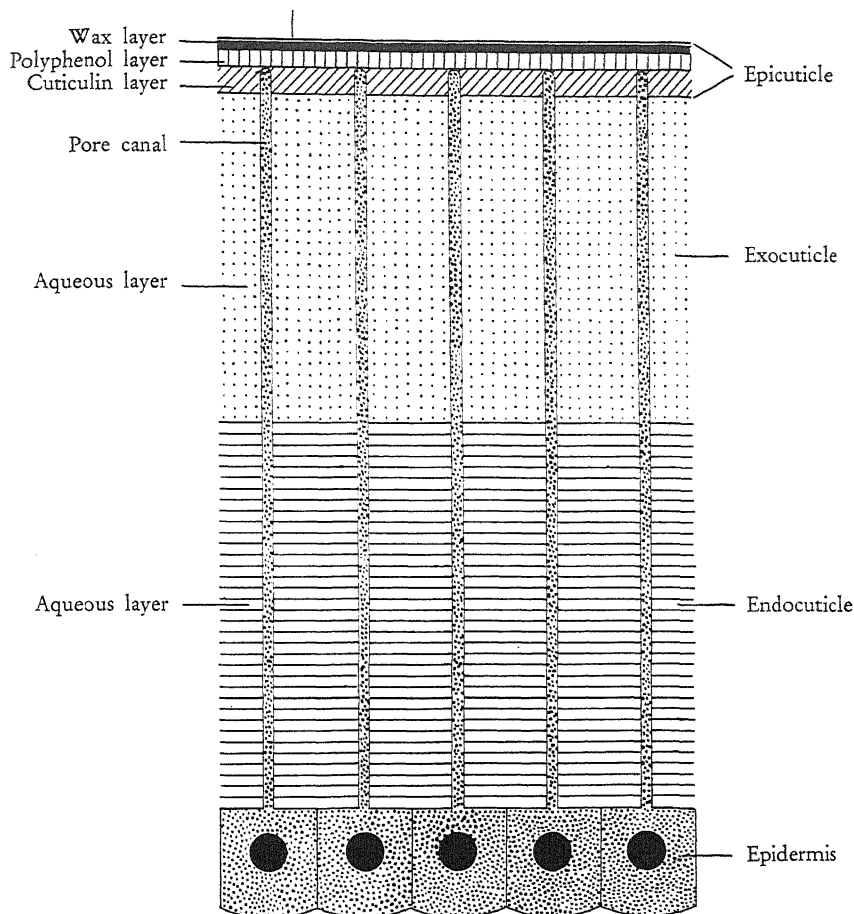


Fig. 1. Diagram showing the structure of the cuticle in *Rhodnius prolixus* (compiled from Wigglesworth, 1947).

wax layer takes place through the bulk of the cuticle and not as an outpouring of wax from dermal glands. Thus it must be pre-supposed that channels are present throughout the cuticle along which such hydrophobe substances could pass. Such a simple concept of insect cuticle as a wax-water system with the water phase penetrated by strands of lipoid or lipophile elements may not be strictly accurate but is of great assistance in the understanding of phenomena involved in the passage of insecticides through the cuticle.

#### *The Effects of Solvents on the Permeability of Cuticle to Contact Insecticides*

Using the sheep ked, *Melophagus ovinus*, as a test insect, and applying to the cuticle insecticidal dusts containing 0.25 % diphenylamine as the toxic agent, Webb and Green (1945) found that the addition of 1 % of certain organic liquids to the powder greatly reduced the time taken for the keds to die as judged by the cessation of heart beat.



Furthermore, this increase in the rate of action of the insecticide was an example of synergy, for the effect was far greater than either that of the insecticide or the solvent applied separately or the sum of their effects when applied together. The ability of the solvent to produce such an increase in rate of action was presumably due to an enhanced rate of penetration of the insecticide through the cuticle and was termed the "carrier efficiency" of the solvent. The carrier efficiency of a number of arbitrarily chosen organic liquids was measured and the results are given in table I.

Solvent	Time of death of keds in hours		Time in hours at which keds became immobile after treatment with solvent control
	Solvent + insecticide	Solvent control	
o-Cresol	1.5	10	1.0
m-Cresol	1.5	9	1.0
Xylenol	1.5	9	1.0
Benzyl alcohol	2.5	21	2.0
p-Cresol	2.5	9	1
Ocyl alcohol	4	30	2
4-Methyl-cyclohexanol	5	30	2
Quinoline	6	27	2
Cyclohexanone	8	26	2
Diacetone alcohol	13	—	—
Cyclohexanol	17	21	2
Acetophenone	22	28	1
Benzonitrile	23	—	6
Aniline	24	—	1
Carbitol	24	26+	20
Dimethyl-aniline	27	—	1
Methyl benzoate	27	27	2
Castor oil	26+	—	—
Anisole	27+	—	—
o-Dichlorobenzene	21	19	3

Table I. *In vitro* experiments with diphenylamine

N. B. Keds dusted with 0.25 % diphenylamine die in 25—30 hr.

From a series of experiments Webb and Green were able to show that the carrier efficiency of a liquid depended on its physical properties and listed those necessary for high carrier efficiency as follows:—

1. The insecticide must be soluble in the liquid.
2. The liquid must penetrate the wax layer of the epicuticle comparatively rapidly.
3. The liquid must possess a high partition coefficient between water and wax, i.e. the fraction, solubility in water/solubility in wax, should be greater than 0.005.
4. The insecticide should be appreciably more soluble in a solution of the liquid in water than in water alone.
5. Where the liquid is applied to the insect under conditions favoring rapid evaporation, (e.g. spread in small quantities upon a dust as against use in bulk solutions) the liquid should be comparatively non-volatile.

Following the isolation of at least the main factors necessary for high carrier efficiency in a liquid, Webb and Green postulated a mechanism whereby a liquid with those properties might increase the rate of penetration of insecticides through cuticle. It was not clear then, however, and is not so now, whether the passage of the insecticide through the aqueous phase of the cuticle involved diffusion across the entire width of the exocuticle and endocuticle before contact was made with living cells or whether only the very narrow region from the base of the wax layer to the tips of the pore canals in the cuticulin layer of the epicuticle was involved. In the latter case transport of insecticide across the greater part of the cuticle might well be facilitated by streaming of cytoplasm within the pore canals. Perhaps both conditions obtain in different insects according to the presence or absence of cytoplasm in the pore canals. In either case the mechanism suggested remains essentially the same. Firstly the solvent with dissolved insecticide either dissolves the epicuticular wax or, disorientating the molecules, passes through the greatly increased intermolecular spaces to the interface between the wax layer and the underlying aqueous phase. Here the solvent, by virtue of its solubility in water (high partition coefficient), passes on into the aqueous phase. The immediate result of this is to reduce the volume of solvent in the wax-solvent phase thereby increasing the percentage saturation of the insecticide in that phase. Thus, at whatever figure that percentage saturation should stand initially, there would always be a tendency for this figure to increase provided that the insecticide is less soluble in water than is the solvent. With increasing percentage saturation of the insecticide in the wax-solvent phase, the rate of passage of the insecticide across the interface will also increase. Further, as the presence of solvent in the aqueous phase raises the solubility of the insecticide in that phase, the partition coefficient of the insecticide will also rise causing a still further increase in rate of passage across the interface. The process, therefore, is analogous to an injection of the insecticide through the waxwater interface. There is every reason to suppose that the percentage saturation of the solvent in the aqueous phase in the immediate neighbourhood of the interface rises to a comparatively high figure because the water permeating the cuticle is free from convection currents tending to disturb the equilibrium.

If this interpretation of the facts is correct, then the mechanism involved whereby a liquid increases the rate of passage of dissolved insecticide across the wax/water interface is purely physical and should obtain with any liquid or mixture of liquids possessing the requisite properties. Webb and Green pointed out that various of the solvents they had used, which showed little or no carrier efficiency because they were deficient in one or other of the properties essential for high carrier efficiency, could be mixed so that the mixture lacked none of these properties. A number of such mixtures were tested, notably carbitol+methyl benzoate and aniline+dimethylaniline, and carrier efficiency above that of either constituent was obtained in almost all cases. Where mixtures such as aniline+benzonitrile were used and no increased carrier efficiency resulted, the failure was found to be due, at least in part, to a much lower rate of penetration of the mixture through beeswax than had been anticipated from the physical properties of the constituents. Similarly, if the physical explanation is true, the mechanism should be capable of extension to insecticides other than diphenylamine. Accordingly tests were carried out with three other contact insecticides namely dioxathogen, *o*-nitrostyrene dibromide and rotenone incorporating a selection of solvents known to show high, medium or low carrier efficiency with diphenylamine. It was found in every case that those solvents possessing high carrier efficiency with diphenyl-

amine behaved in a similar manner with the other three insecticides. There is, therefore, good evidence to suggest that the mechanism proposed is substantially correct.

### Conclusions

From the foregoing work it is possible to draw certain conclusions not previously fully realised concerning not only the mode of penetration of at least some contact insecticides but also the physical properties of those insecticides responsible for penetration of cuticle. If the method of penetration suggested above is correct, we may infer that insecticides of the diphenylamine type normally pass directly across the cuticle by diffusion either as far as the ends of the pore canals or to the epidermal cells beneath the endocuticle, and that this process can be greatly speeded up by purely physical means, namely the addition of a suitable solvent. The most important aspects of this concept, so far as formulation of new insecticides is concerned, lies in the realisation firstly that the ability of the insecticide to dissolve in water is as important if not more so than its solubility in oils and fats and, secondly, that insecticides such as rotenone and dioxathion are capable of exerting their toxic effects when present in extremely small quantities. With regard to this last point it should be noted that rotenone and dioxathion are only soluble in water to the extent of c. 0.1 mg/100 c. c. and c. 0.25 mg./100 c. c. respectively. This means that the tendency for these insecticides to remain in an oil phase would be so great that only extremely small quantities could pass into the aqueous phase.

The possibility of mixing solvents to give a liquid possessing requisite properties for carrier efficiency led to an attempt to improve existing media for flysprays. As the usual base for flysprays is kerosene, a liquid capable of penetrating cuticular wax readily but almost insoluble in water, it was thought probable that, by adding a suitable liquid providing the remaining physical properties, the rate of penetration of the toxic agent used in the spray would be increased and an improved rate of knockdown of flies would result. Among other liquids tested, benzyl alcohol was found to possess the correct physical properties and, moreover, was only 5% soluble in flyspray kerosene, an important point for the percentage saturation of benzyl alcohol in kerosene must be high if it is to leave the kerosene readily and enter the aqueous phase of the cuticle. Thus a flyspray consisting of kerosene saturated with benzyl alcohol and using D.D.T. as toxic agent was found to increase the rate of knockdown of *Musca domestica* very considerably in comparison with sprays lacking either benzyl alcohol or D.D.T. In spite of this success, however, the rate of knockdown of flies with a kerosene-benzyl alcohol-D.D.T. spray was not nearly so rapid as that obtained with pyrethrins in kerosene. Furthermore, the addition of benzyl alcohol to a pyrethrin-kerosene spray did not appreciably improve its rate of knockdown. It appears, therefore, that pyrethrins are outside the scope of action of liquids with carrier ability and, as it seems carrier efficiency depends on a physical mechanism, it can only be concluded that a separate class of insecticides exists, of which pyrethrum is a member, penetrating cuticle in a manner different from that of diphenylamine.

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**Arsenical Lime Sulphur Z-ALS, AN EFFECTIVE INSECTICIDE  
FOR THE CONTROL OF THE COTTON-LEAF WORM, *Prodenia  
litura* F., AND OTHER CHEWING INSECT PESTS AND  
PREVENTING BUILD-UP OF THE COTTON APHID**

By *M. S. El Zoheiry (Bey)*

In a paper addressed to the XVIII International Cotton Congress, held at Cairo-Alexandria, January—February 1938, under the title "The control of the cotton leaf-worm, *Prodenia litura* F., in Egypt by Dusting and Spraying", the speaker discussed the methods recommended for the control of the cotton leaf-worm in Egypt viz.:

- (1) Picking of the egg-masses before hatching and collection of newly hatched larvae.
- (2) Prohibition of watering of clover after May 10th to reduce, to a minimum, the number of moths emerging from clover, in which the early broods of the cotton-worm breed unchecked.
- (3) Trapping of moths by light or bait traps.
- (4) Utilisation of the natural enemies of the pest (predators, parasites and diseases).

After discussing the merits and drawbacks of each of these methods I mentioned that there was great cause to find out some other methods of control to supplement the method of egg-mass collection in cases of hatching and where labour supplies are inadequate or the nature of growth of other host plants does not allow hand picking of egg-masses. Then I said that the experience of other nations fighting similar insect pests with insecticides was made use of in solving this problem in Egypt and that systematic investigations on this subject were resumed and continued until 1930 when commercial calcium arsenate and Meritol, applied as dusts, gave satisfactory results in killing the young larvae but their application caused build-up of the cotton aphid. The problem became more complicated and the object of the investigations became twofold; the insecticide which should kill the cotton leaf-worm should also cause no aphid infestation or at least prevent the build up of the cotton aphid.

Repeated experiments carried out in different localities in Lower Egypt during the period from 1931 till 1934, with fifty different insecticides containing arsenical compounds of calcium, lead and copper, with and without aphidicides such as rotenone, nicotine sulphate and pyrethrum; and compounds of fluorine-cryolite, Barium and Sodium fluosilicates; and several patent insecticides revealed the effectiveness against the cotton leaf worm and the cotton aphid of a mixture of equal parts by weight of Calcium arsenate, hydrated lime and sulphur prepared by the speaker and named Z-ALS or Arsenical lime sulphur.

In preparing this mixture care was taken to use calcium arsenate of a low water soluble content of arsenic, not more than 0.75 % (Delta brand calcium arsenate). Hydrated lime was procured locally by slaking high grade quicklime with water (never leaving it to stand overnight to prevent formation of calcium carbonate). After slaking it is brushed on narrow mesh sieves several times and is finally sifted through 300 mesh sieves. Sulphur is also imported fine enough to pass through 300 mesh. The three ingredients are added in equal parts by weight in the feed of an electric mixing and grinding machine and pass through a horizontal hard brush turbine before

falling into the mixing box. In this way a fine homogenous mixture of arsenical lime sulphur is obtained.

The reason for adding hydrated lime to the calcium arsenate is to prevent or neutralise the formation of arsenic acid on sensitive foliage. Depending on its source, lime has either a high magnesium or a high calcium content. The former is preferred in making the mixture; it increases the yield.

Sulphur was added because it is an important contact poison both as straight sulphur and as lime-sulphur. Its addition to the calcium arsenate and hydrated lime prevented build-up of the cotton aphid. It is also effective in the control of red spider, which is another pest of cotton in Egypt, and acts as a stomach poison for young caterpillars. The mixture contains 12—14 % total arsenic pentoxide (average 12.7 %) and 32—34 % pure sulphur (average 32.3 %); the water soluble arsenic content is 0.17 per cent.

It was applied in the 1934 cotton worm campaign for the treatment of 2,143 acres of cotton, 1,006 acres of pea-nuts, 450 acres of water-melon, 188 acres of sweet potatoes, 66 acres of maize and 130 acres of various other crops—a total of 3,983 acres.

In 1935, the cotton worm attack was so overwhelming that hatching took place in large areas in the northern provinces of the Delta and in two provinces in Upper Egypt. Dusting with arsenical lime sulphur was applied in all cases where hand-picking of egg-masses failed to combat the pest; about 14,000 acres were dusted. It happened that dusting was very heavy in certain cases because of lack of trained workmen and was followed after three applications by an aphid attack, more especially in areas where the heavy attack of the cotton worm caused severe defoliation followed by new tender vegetative growth which was very attractive to both cotton worm moths and aphids. Proper, even and light dusting was not followed by aphid attacks.

In 1936 and 1937, motor dusters and Root hand-gun dusters with feed adjustment were imported and used for treating cotton and other crops as well as fruit and shade trees attacked by the cotton worm. Trained workmen were employed and no unusual aphid attack developed on treated plants.

In 1940 the Advisory High Council of Agriculture decided that a large scale experiment should be carried out by the Entomological Section as a final test of Arsenical lime sulphur. Twenty one plots, each 100 acres were chosen in different parts of Lower Egypt. Dusting was applied before the hatching of egg masses and each plot received three dustings at intervals of 20 days. One plot was treated by a spray of 600 gms. of arsenical lime sulphur mixture per 100 litres of water. Dusting and spraying were very successful in killing the larvae, 2 till 3 days after hatching. No aphids appeared in 18 plots which received three light dustings with arsenical lime sulphur alone. Because of shortage of arsenical lime sulphur, three plots were dusted in the 3rd treatment with Meritol (35 % calcium arsenate mixed with magnesium silicate and waxy substances as stickers). Although free from aphids after the two preceding applications they were attacked by aphids after treatment with Meritol. Infested weeds were a factor in the spreading of aphids in these three plots. Since 1941, arsenical lime sulphur was the standard insecticide for the control of certain insects viz. the cotton leaf worm (*Prodenia litura* F.), the lesser cotton worm (*Laphygma exigua* Hb.), the leaf-eating ladybird beetle (*Epilachna chrysomelina* F.), and the orange-red leaf-beetle (*Raphidopalpa (Aulocophora) foveicollis* Lucas) and the American bollworm (*Heliothis obsoleta* F.). When the last war was over DDT, Gammexane, Ryanex, Hexaethyl tetraphosphate (or vapotone), E 605 (a phosphoric acid ester) and many other new organic insecticides have been the cause of enthusiasm and

cherished the hope that one of these wonderful chemicals would take care of all pests at once.

Experiments carried out with these new chemicals against the cotton leaf worm gave no better results than arsenical lime sulphur. Heavy aphid attacks followed DDT applications; used properly on certain crops for specific insects, DDT did a remarkable job, and so did many others of the new insecticides; but they are a two-edged sword. Their potency makes them capable of doing damage; the advantage of control of undesirable species of insects by these insecticides was more than offset by the detriment to desirable and beneficial forms. The wide publicity given to the new insecticides which mushroomed up during the war and their reactions on beneficial and harmful insects have served to awaken us to the value of insect parasites and predators.

Arsenical-lime-sulphur is no exception, but it is much less potent. In conclusion, I request to suggest that insect control workers in other countries may be interested in testing this mixture against similar leafeating insects and comparing its effectiveness and low cost with those of the new insecticides.

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## SECTION X

BESCHAFFENHEIT DER NATURWISSENSCHAFTLICHEN INSTITUTE BEI  
DER BULGARISCHEN AKADEMIE FÜR WISSENSCHAFTVon *Neno Atanassov*

Die naturwissenschaftlichen Institute der Bulg. Akademie für Wissenschaft bestehen aus:

1. — Institut für Zoologie, 2. — Zoologischer Garten, 3. — Botanisches Institut, 4. — Botanischer Garten, 5. — Geologisches Institut, 6. — Naturwissenschaftliches Museum, 7. — Wissenschaftliche Bibliothek.

In diesen Anstalten arbeiten Akademiker als wissenschaftliche Leiter der Institute als wissenschaftliche Mitarbeiter Fachleute wie: Zoologen, Entomologen, Botaniker, Geologen, ferner Assistenten und technisches Personal.

Die Devise, welche die Wissenschaftler bei den naturwissenschaftlichen Anstalten und Museum leitet, ist: „Durch die Wissenschaft zu einem kulturellen und wirtschaftlichen Aufschwung Bulgariens“.

Es ist bekannt, dass Bulgarien ein Agrarland mit schwach entwickelter Industrie ist. Um richtig die natürlichen ober- und unterirdischen Bodenschätze in Beziehung zum zweijährigen Volks-Wirtschaftsplan ausbeuten zu können, haben es sich die naturwissenschaftlichen Institute der Bulgarischen Akademie für Wissenschaft zur Aufgabe gestellt, Bulgarien umfassend und allseitig zu studieren: ihre Flora, Fauna, Geologie, Paleontologie, ihre Mineralien und Bodenschätze.

Die naturwissenschaftlichen Institute und das Museum bei der Bulg. Akademie für Wissenschaften haben fast ein halbes Jahrhundert Geschichte und Tätigkeit hinter sich. Sie entwickelten sich allmählich und zwar formierte sich zuerst das Institut für Zoologie, dann die Botanische Anstalt und zuletzt das Geologische Institut.

1. — *Das Institut für Zoologie* — gegründet im Jahre 1889 — als die grösste Abteilung des ehemaligen Naturhistorischen Museums, erreicht den grössten Aufschwung. Es hat reiche und gut angelegte Sammlungen. Seine Abteilungen gliedern sich in  
a) Wirbeltiere, spezifiziert in Säugetiere, Vögel, Kriechtiere, Fische und Landwassertiere.  
b) Insekten und niedrige Tierarten mit einer Sektion Höhlen-Fauna.

Zusammen mit rein wissenschaftlichen Fragen, wie der Herausgabe der Fauna Bulgariens, stellt sich das Zoologische Institut auch Aufgaben zur Forschung auf dem Gebiet der angewandten Zoologie, so weit es sich um Probleme im Zusammenhang der Schädlichkeit und Nützlichkeit der verschiedenen Säugetiere und Vögel handelt, welche Jagdobjekte vorstellen, ferner solcher, welche eine wichtige Rolle in wirtschaftlicher Hinsicht für die Völker spielen.

Es wird auch in Fragen auf dem Gebiet der Biologie der Schädlinge in Verbindung auf die Kultur-Pflanzen und Wälder, der Haustiere, sowie auch der Bazillenträger auf Menschen und deren Bekämpfung gearbeitet.

Diese speziellen, wissenschaftlichen Forschungsaufgaben, wurzeln in ihrer Grundlage auf den wissenschaftlichen Plan, den sich die Bulg. Akademie der Wissenschaften für das Jahr 1948 gestellt hat und der ebenfalls in Beziehung zum Zwei-Jahresplan steht.

Im Zoologischen Institut befindet sich eine Zentrale für Ornithologie, die rege am internationalen Dienst zur Erforschung der Zugvögel durch Markieren derselben mittels Ringen teilnimmt.

2. — *Zoologischer Garten*. Derselbe ist zu einem wissenschaftlichen Institut umgewandelt, welches neben seinen wissenschaftlichen Arbeiten sich bemüht, eine richtigere Anordnung der Tiere zu natürlichen Gruppen zu treffen. Gründungsjahr 1889.

3. — *Botanisches Institut*. Dieses wurde im Jahre 1918 gegründet. Es besitzt eine reiche Sammlung bulgarischer und europäischer Pflanzen. Hier wurden einige Monographien der Flora Bulgariens und ein Wörterbuch der Botanik ausgearbeitet. Im gänge sind Forschungen auf dem Gebiet des Wiesen- und Weidenpflanzenwuchses. Ferner wird an der Herausgabe eines Werkes über die Flora Bulgariens gearbeitet.

4. — *Botanischer Garten*. Dieser hat reiche Sammlungen seltener Pflanzenarten, sowie auch Alpen-Flora, reich hauptsächlich an seltenen bulgarischen Pflanzen, welche an verschiedenen Orten und in verschiedenen Höhen über dem Meeresspiegel heimisch sind. Der Botanische Garten stellt es sich zur Aufgabe, natürliche Sammlungen der bulg. Flora im Terrain sowie auch im Gewächshaus zu bieten.

5. — *Geologisches Institut*. Dieses besteht aus zwei Abteilungen: „Mineral-Petrographische- und Geologo-Paleontologische. Dasselbe stellt sich rein wissenschaftliche Forschungsaufgaben in Beziehung zum Magmatismus, Bergbau und den Mineralien. Gegründet im Jahre 1919.

Ferner wird gründlich über Stratigraphie, Tektonik und Paleontologie des Landes gearbeitet. Ebenso nimmt man ein ausführliches Kartieren zum Zweck der Ausgabe einer genauen geologischen Karte Bulgariens vor.

Dem Geologischen Institut sind auch wichtige in der Praxis anwendbare Aufgaben übertragen, ebenfalls in Beziehung zum 2-Jahres-Wirtschaftsplan und zwar: geologische Forschungen in Beziehung zu den grossen xydrotechnischen Bauten, Schleusen, Elektrozentralen u. s. w., wie auch die Erforschung der unterirdischen Bodenschätze des Landes; der Kohlen, Erze und Mineralien im Zusammenhang zu ihrer Industrialisierung.

6. — *Naturwissenschaftliches Museum*. Gegründet im Jahre 1889 als Naturhistorisches Museum. Die Sammlungen des zoologischen, geologischen und botanischen Institutes bilden das Naturwissenschaftliche Museum. Dasselbe umfasst 25 gut angeordnete Säle und 5 Vorräume. Die Reichtümer des Naturwissenschaftlichen Museums übersteigen eine Million Exemplare, über 10.000 Arten, systematisiert und zum Teil biologisch in schönen Eisen- und Holzvitrinen eingeordnet.

Die Sammlungen des Museums geben einen vollen Überblick der Natur Bulgariens, — ihrer Flora, Fauna und Bodengestaltung.

Das Naturwissenschaftliche Museum hat folgende Abteilungen:

A) Wirbeltiere mit den Sektionen — Säugetiere, Vögel, Kriechtiere, Fische und Landwassertiere, über 40.000 Stück bulgarische und fremdländische Arten, in 14 Sälen angeordnet. Die Sektion — Angewandte Zoologie — besteht aus reichen Trophäen von Hirsch-Geweihen, Rehen, wilden Ziegen, Zähnen von Gliganen u. s. w. sowie auch Vertretern unseres Jagdreichtums.

B) Insekten. Diese Sektion enthält 500.000 Stück Insekten, von welchen 350.000 präpariert sind und 150.000 wissenschaftliches Material darstellen. In ihr sind fast alle Sammlungen der bulg. Entomologen seit der Befreiung Bulgariens bis heute aufbewahrt. Wertvoll sind die biologischen Kollektionen der nützlichen und schädlichen Insekten.

An diese Sektion ist ein Laboratorium zur Ergründung der Krankheiten und Feinde der Bienen angegliedert.



C) Niedere Tierarten. Hier sind hauptsächlich Arten vom Schwarzen- und vom Weissen Meer (Egäischen Meer) ausgestellt, die in drei Sälen angeordnet sind. Diese Sektion besitzt auch fremdländische Arten und zwar aus dem Uferland Amerikas.

Sektion Höhlen-Fauna. Die ganze bekannte Höhlenfauna Bulgariens ist hier ausgestellt, publiziert und zum Teil nicht publiziert. Vorläufig werden auch Reste von ausgestorbenen Höhlen-Wirbeltieren aufbewahrt.

D) Die Botanische Abteilung des Museums. — Sie ist im Besitz von über 100.000 bulg. und europäischen Pflanzen, mit der Tendenz, dass unsere Heilpflanzen, fett-absondernde, endemische und dekorative Pflanzen in Zukunft ausgestellt werden. Diese Abteilung umfasst zwei Räume.

E) Geologisch-Paleontologische und Mineral-Petrographische Abteilung stellt gut angeordnete Sammlungen dar, hauptsächlich Bulgariens Naturschätzen entnommen. Hier sind ungefähr 12.000 Vertreter verschiedener Mineralien, Erzen u. s. w. ausgestellt und ungefähr 20.000 Steinarten, fast alle in Bulgarien gesammelt. Diese Abteilung füllt drei Säle.

F) Laboratorium zum präparieren. Dieses ist mit dem nötigen Inventar und Hilfsmitteln zum präparieren und montieren aller Arten Tiere ausgestattet.

Auf Grundlage des reichen, naturwissenschaftlichen Materials, in den Sammlungen des Museums eingegliedert, sind von den wissenschaftlichen Mitarbeitern der Institute und des Museums über 1.200 wissenschaftliche Beiträge zur Fauna, Flora und der Bodenschätze Bulgariens ausgearbeitet und einige Monographien über Schmetterlinge, Spinnen, Wassertiere, Kriechtiere, Vögel, Fische u. s. w. publiziert worden.

Hand in Hand mit den rein wissenschaftlichen Arbeiten sind in vielen Ausgaben auch Fragen der angewandten Zoologie behandelt, besonders wenn es sich um nützliche und schädliche Tiere für die Volkswirtschaft und Gesundheitsgefährdung handelt. Besonders wertvoll sind die Studien über die Biologie der Schädlinge auf den kultivierten Pflanzen, Wäldern, Haustieren und den Menschen.

Avd. X—XI—7 Neno Atanasov — spalt 2

Das Naturwissenschaftliche Museum ist der Mittelpunkt aller bulg. Naturforscher und die Quelle des naturwissenschaftlichen Gedankens bei uns. Es ist tatsächlich ein leicht zugängliches Volks-Institut.

Das Museum hat die Bedeutung eines kulturellen, aufklärenden und pädagogischen Faktors im Leben unseres Landes. Es wird hauptsächlich von der Jugend besucht — Schülern, Studenten, von ihren Lehrern und Professoren geführt, zu wissenschaftlicher und pädagogischer Aufklärung und Vertiefung. Grosses, diesbezügliches Interesse zeigt auch die Bürgerschaft. Auf diese Art macht das Museum die Naturwissenschaften volkstümlich und verständlich für die Allgemeinheit.

Der Weg, den die Besucher zurücklegen müssen, um alle Sammlungen des Museums in Augenschein zu nehmen, beträgt 2.600 m.

Im Jahre 1942 hatte es 152.855 Besucher aufzuweisen.

7. — *Bibliothek.* Die wissenschaftliche Bibliothek umfasst zwei grosse Säle, mit 20.000 Büchern, 520 verschiedenen naturwissenschaftlichen Zeitschriften, von welchen 384 aus 33 ausländischen Staaten sind. Diese Zeitschriften werden auf dem Tauschweg gegen unsere Ausgabe „Nachrichten der Wissenschaftlichen Institute und des Museums“ zugesandt.

## DISCUSSION ON ENTOMOLOGICAL NOMENCLATURE

## INTRODUCTION

By *Per Brinck*

At the 7th Entomological Meeting of Northern entomologists in Helsingfors, in 1947, the appointing of a Committee on Problems of Entomological Nomenclature was resolved. The six Entomological Societies of the Northern Countries later on elected a representative each to this Committee, which had to investigate, and to bring forward to discussion, the current nomenclatorial problems. The results were to be compiled by the Committee so that they could be presented before the sittings of the present Congress. The complaints which have arrived are, however, so many and so varying that it has proved impossible to take them all in regard here—only those, having a more central importance will be considered. The chief part of the previous work within the Committee has been handled by Dr. C. H. Lindroth, Djursholm. The final discussion of the material has been left in my care.

One of the most difficult problems for all sections of entomological research is the instability of the generic and specific names. Within certain groups of insects, especially in Lepidoptera and Coleoptera, the changes of the names are so repeatedly occurring, and the interpretations of the older names are so varying, that it is in many cases impossible to know what an author means when using a certain name, if a description is not given at the same time, or if he does not give any references to previous authors. This is, in fact, a reversal to pre-linnaean systematics, to the time when a species had to be furnished with a short description or a detailed reference in order to be recognized.

The causes of this instability appear to be problems of taxonomy as well as nomenclature. The taxonomic questions certainly do not belong to the sphere of decisions of this section, but since they form part of the complex, it seems motivated to mention them here. They are the following: the division of genera and species into several new ones, a tendency which has gone very far in certain insect groups, and the abundant describing of races, varieties, and aberrations, in many cases on rather loose grounds. It is obvious that especially the splitting of the species and genera must influence the stability of the generic and specific names rather strongly, as the divisions involve the introduction of new names for parts of a population which was previously considered homogenous, and as, furthermore, these changes are rather often done in such a manner as to make it necessary for later authors to make new changes of the names in accordance with the type material, when this is revised.

The most important cause of the instability of the generic and specific names appears, however, to be found in the circumstance that the international rules of zoological nomenclature crave a strict application of the priority law, which seems to encourage many authors to carry out changes to a much larger extent than would be necessary. It is probably unnecessary to give any examples of this well-known fact here. From having been rather troublesome during the first decades of this century, the phenomenon in question has now become a torture to a great many entomologists (especially those who are not working taxonomists), as a large percentage of the changes now carried out results in greater confusion than uniformity. Scandinavian and Finnish zoologists

since long, with a few exceptions, have been opponents to the strict application of the law of priority. Thus we remember for instance the vote against this law in *Zoologischer Anzeiger*, Vol. 39, 1932, where 22 Scandinavian zoologists objected to the strict application in all cases and expressed the desire that the most important and generally used names should be protected against any change on nomenclatorial basis. As far as we know, this opinion is still held by the Northern entomologists.

There are several possible ways to protect current names against rejecting or changing from purely nomenclatorial reasons. The simplest way appears to be their successive acceptance as *nomina conservanda*. With regard to the generic names, this is a method which has long been in use; the placing of them in the Official List of Generic Names has not, however, proceeded to such an extent as to have played a more important rôle. Further, there is no equivalent with regard to the specific names. As was pointed out by Dr. Mortensen at the 10th International Zoological Congress in Budapest, 1927, however, it must be considered very appropriate that also at least more important specific names can be retained as *nomina conservanda*, when other means of securing the stability can not be used. However, if the *nomina conservanda* are to contribute to the disappearance of the instability of generic or specific names, a much more extensive usage of them than the present one is necessary.

It would also be possible to protect the current names by other methods, yet involving a more or less extensive change of the scope of the now valid nomenclatory rules. Thus it has been proposed that names which have been accepted and unchallenged for 25 (30, or 50, alternatively) years should be irreplaceable. The first suggestion of this kind was made already at the second Entomological Congress in Oxford, 1913. —It seems unnecessary to me, here to give a closer account of the well-known continuity principle of Heikertinger. It is apparent that it has many supporters, but only *few* consider it possible to be carried out, as this would imply good-will and objectivity to an extent which appears to be impossible to reach for many modern taxonomists.

Perhaps a compromise between the principle of priority and the principle of continuity could help us out of the difficult position which is involved by the increasing instability of the names. Most of, and probably also the most unnecessary of the name changes appear to be caused by the dragging forth of old publications, from which previously not noticed names are taken and are given back to zoology, where they take the place of names which are often old and well-known. It would be a great advantage, if such parts of these old works which were considered undigestable by previous generations (which often had better opportunities of judging the contents of these publications than we have) could be eliminated from the discussion. This may be effected by the introduction into the nomenclatory rules of an article saying that a name of a genus or of a species, given before a certain year and which has not, during a certain period, been used in the scientific literature, must not supplant a younger name which in other respects is quite valid.

A most repulsive nomenclatorial change is the transferring of a generic or specific name from a genus or species to another. At the Zoological Congress in Monaco 1913, Brauer suggested that a new article were to be inserted after the article 13 of the nomenclatory rules, *i.e.* implying that exceptions from the priority law should be allowed when a generic or specific name had to be transferred to another valid genus or species. In the sentences following Article 36 in the nomenclatory rules, dealing with Suspension of Rules in Certain Cases, it is pointed out that

the authority of the Nomenclatory Committee to suspend the rules primarily applies to . . . the transference of names from one genus or species to another. It is regrettable that very slight, if any, results of this have appeared. However, it appears difficult generally to prohibit such transferring by the introduction of a special clause in the rules. The results of such a measure would be important and perhaps rather surprising to many entomologists on several parts of Entomology. On the other hand we have the possibility of emphasizing the authority of the Committee in this respect, as has been done in the proposal below.

And so, finally, some questions of procedure. As generally known, the Nomenclatory Committee has the possibility to suspend the rules under certain conditions. One of these is that the Committee has to be unanimous on the point of the suspension. If a majority of two thirds is found, the question has to be passed on to the international zoological Congress, where the president of the nomenclatorial section has to elect a special board of 3 members, which shall deal with the question. To many Northern zoologists it has appeared desirable that the decisive authority of the Committee be increased, so that a majority of  $2/3$  should be enough for the decision of the respective questions. Further, if such a majority could not be reached, the debated points should be presented to the nomenclatorial section of the first occurring international Congress of Zoology, which, after having discussed the problem, should have the opportunity of giving the Committee the authority to decide on the question with simple majority, for each special case.

The discussion of these questions in Denmark, Finland, Norway, and Sweden has resulted in some proposals, which are well worth to be further discussed here, so that they, with or without a recommendation, can be presented to the Nomenclatorial Committee. Of course, parts of the proposals are alternative.

1. A considerable extension of the transferring of names to the Official List of Generic Names. For each name in this list the type of the genus should be stated. The retaining of the name is not sufficient; the most important point is that it should have the same meaning as previously.
2. The introduction of an Official List of Specific Names. Here species names should be recorded according to the same principles as applied to the recording of generic names in the above-mentioned list. Yet, the appearance of a specific name together with a certain generic name should not imply a fixation of the species to the genus in question.
3. Reduction of the nomenclatorial validity of the older literature. It should be prescribed that a generic or specific name, given before (1850) but which has not been used in scientific literature since (1st of January, 1900), should be suppressed to the advantage of every such name which has been in common use for the genus or species in question since the lastmentioned date.
4. A change of the decisive power of the International Zoological Nomenclatory Committee. The suggestion is most vividly illustrated by the citing of the respective parts of the zoological nomenclatory rules, with the suggested changes made. The changes are printed in italics.

*Suspension of the Rules in Certain Cases.*

RESOLVED.—That plenary power is herewith conferred upon the International Commission on Zoological Nomenclature, acting for this Congress, to suspend the Règles as applied to any given case, where in its judgment the strict application

of the Règles will clearly result in greater confusion than uniformity, provided however, that no less than one years (half a years, alt.) notice shall be given in *the Bulletin of the Commission and in some other selected suitable journals*, that the question of a possible suspension of the Règles as applied to such case is under consideration, thereby making it possible for zoologists, particularly specialists in the group in question, to present arguments for or against the suspension under consideration, and provided, also, that the vote in Commission is *at least two thirds majority of the full Commission*, and provided further, *that if the vote is not two thirds majority, may it be for suspension or for application of the Règles, the case is to be presented to the Section on Nomenclature of the next International Congress of Zoologists, which after discussion of the case shall have the possibility to endow the Commission with the power to revise the case once more and then to make a final decision by simple majority.*

This decision shall be without appeal; and

RESOLVED.—That the foregoing authority refers especially to cases of names of larval stages and the transference of names from one genus or species to another; and

RESOLVED.—That the Congress fully approves the plan that has been inaugurated by the Commission of conferring with special committees from the special group involved in any given case, and that it authorizes and instructs the Commission to continue and extent this policy, *and also, to present its votes as fast as possible without impairing the solicitude necessary for the decisions.*

*Recommendation: In such cases of transference of names to other genera or species, which will clearly result in greater confusion than uniformity, the question is to be placed before the Commission without delay. The Commission is to investigate the problem immediately and to present a vote on the case, if necessary by suspension of the Règles. In the meantime, the species involved are to be named as if the error had not been detected.*

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## DER GATTUNGSBEGRIFF BEI LINNÉ

Von *Felix Bryk*

Der Gattungsbegriff an sich gehört in das Gebiet der Erkenntnistheorie, ja ist — wenn man so will — sogar eine transzendente Frage. Er hat seine Wurzel im archaischen Denken und ist, genau genommen, derart mit dem Artbegriff verwachsen, dass es heute schwer fällt zu entscheiden, welcher von beiden der ursprünglichere ist und welcher der abgeleitete, so verwischen sich die Grenzen untereinander.

Es würde uns ausserhalb des Rahmens unseres zeitlich eng umgrenzten Themas führen, wollte ich auf die Auffassung der Primitiven, ja selbst der Antike und des Mittelalters zurückgreifen. Es genügt bei Schopenhauer Halt zu machen, einem weissen Raben unter den deutschen Naturphilosophen, weil er auch für die Naturwissenschaften ein klares und offenes Auge hatte — ich erinnere nur an die erkenntnistiefen Gedankengänge in seinem „Willen in der Natur“. Bei Schopenhauer finden wir eine Distinktion des Objektivierten, die jeden Gegenstand wie mit einer Zauberformel durch einen Gattung- und gleichzeitig Artnamen ergreift, wobei der düstere Weltweise ausdrücklich auch Linnés binäre Denkweise anführt.

Wir wollen mit einem Schulbeispiele unsere Betrachtung einleiten. Nehmen wir einen Gegenstand aus der Technosphäre, sagen wir beispielsweise den Tisch. Ist er als Art oder Gattung gedacht? oder als beides? Darüber ist sich wohl der Durchschnittsmensch kaum im klaren, weil — wie wir später zeigen werden — beide Begriffe selbst von den Fachleuten oft verwechselt wurden, und weil ihn diese Frage einfach nicht interessiert. Es gab einmal einen Tisch, aber heutzutage gibt es keinen Tisch an sich: es gibt indessen einen Speise-, Schreib-, Nacht-, Wasch-, Spiel-, Toiletten-, Operationstisch u. s. w. Setzen wir *mensa* als Gattung für den Tisch an sich, so hätten wir für die einzelnen Aufteilungen der ursprünglichen quadrupeden Tischvorstellung je einen Trivialnamen zuzusetzen, der sich sogar auf ein einbeiniges Möbelstück beziehen könnte.

So ähnlich stellte sich und stellt sich noch immer weiter der Laie, sicher beeinflusst von den systematisch unzulänglich unterrichteten Schriftstellern der Antike und des Mittelalters, zur belebten Welt. Für ihn gibt es freilich z. B. einen Mausbegriff, mit dem er sich wohl zunächst unsere Hausmaus vorstellt, aber auch Feld-, Hasel-, Spitzja sogar Fledermaus können unter die Kategorie der Mausvorstellung fallen. Ob er dabei den verwandtschaftlichen Beziehungen Gewalt antat oder nicht, was hat das für ihn zu bedeuten? Maus ist Maus!

Bei der Inventarisierung der Biosphäre, die letzten Endes in eine systematische Einteilung der Tier- und Pflanzenwelt münden musste, verfuhrten die alten Naturforscher nach demselben Prinzip. Genau so wie der Laie gingen sie von einem Einzelfalle — überwiegend vom gewöhnlichsten — aus, und ihn vergleichend mit ähnlichen oder ihnen ähnlich erscheinenden Geschöpfen — und die Auffassung der Ähnlichkeit ist je nach dem Grade der Phantasie, des Wissens und der Kritik dehnbar wie Kaugummi — bildeten sie sich einen Sammelbegriff, der unserem heutigen Gattungsbegriffe in *nuce* entsprechen würde. Dass aber unter der Gattung ursprünglich eine Art von einer Pflanzen- oder Tierform gedacht wurde, dafür gibt es verschiedentliche Belege: wir finden sie zunächst durch die Etymologie des Wortes, die so oft den wahren Sinn eines Begriffes aufdeckt, festgelegt. Wie bei den Griechen „γενος“ von „γεννῶμαι“ oder bei den Römern „genus“ von „gignere“ abzuleiten ist, also von zeugen, gebären und

ursprünglich Abstammung bedeutete, so stammt das deutsche Wort Gattung, das noch als „*gatunek*“ im Polnischen den Artsinn bewahrt hat, ab von dem, was sich untereinander begattet<sup>1</sup>. Und noch am Anfange des 18. Jahrhunderts finden wir beim grossen Blumenbach in seinem sehr verbreiteten „Handbuch der Naturgeschichte“, die viele Auflagen erlebt hat, die Bezeichnung Gattung ausdrücklich für Species angewandt. Aber wir lassen die alten Gattungsnamen, wie sie uns Carl von Linné selbst überliefert hat, gleichviel ob er sie wie oft von den Patres übernommen hat oder nicht, zu Worte kommen, das überzeugt mehr als etymologische oder sprachliche Befunde. Dort gibt es einen *Homo*, *Canis*, *Elephas*, *Bos* (merkwürdigerweise nicht *Pecus* oder *Taurus* sondern ausgerechnet einen Kastraten!) u. s. w. als Gattungsnamen avanciert, während sich die zu jeder dieser Gattungen gehörenden Einzelarten wie Mensch, Hund, Elephant oder Rind mit Eigenschaftsnamen wie *sapiens*, *familiaris*, *maximus*, *domesticus* (oder *taurus*) abfinden müssen. Also die ursprüngliche, geläufige Bezeichnung für eine Art ging mit der Zeit — wenigstens in der Systematik — verloren, die Art wurde zu einer Gattung erhoben oder drastisch ausgedrückt: die Gattung sensu primitivo wurde degradiert, indem sie in Arten zerlegt wurde!

Linné, der nur den strahlenden Endpunkt einer langen, scholastischen Entwicklungsepoche der Naturwissenschaften bezeichnet, war durch und durch Kompilator — ein genialer Kompilator! — aber er ist keineswegs der erste, der die Gattung als höhere Kategorie in die Botanik und Zoologie eingeführt hat. Schon der Italiener Andreas Caesalpinus im 16. Jahrhundert und der Basler Caspar Bauhinus gaben jeder Pflanzengattung einen Namen, aber erst der Franzose Tournefort, der Ende des 17. Jahrhunderts tätig war, begründete die Gattungen fest und brachte sie zur allgemeineren Anerkennung. Auch die Gattungen der Tiere fand Linné vor, zuletzt klar und vollständig vom Engländer John Ray entwickelt, der z. B. von einem *genus bovinum* spricht.

Auch die binäre Nomenklatur, die sich folgerichtig als Ergebnis des Gedankentummelplatzes für Gattung und Art einstellen musste (als praktisches Schlussergebnis der sich sonst wie ein Bandwurm ziehenden vielwörtigen Namensgebung), hat in Linné nicht ihren Begründer. Sie war schon „vom Leipziger Professor Bachmann, latinisiert Rivinus, im Jahre 1690 vorgeschlagen“ und von Linné (nach Nägeli) „in seinen ersten Schriften sogar verworfen und bekämpft“. In der Zoologie ist es wohl der Franzose Belon, der zuerst, bereits in der Mitte des 16. Jahrhunderts die Tiere binär anführte.

Solange die Artkonstanz keinen Einzug in unsere Erkenntnis gewonnen hatte, musste der genetische Zusammenhang zwischen einzelnen, nahestehenden Tier- und Pflanzengruppen gelatinös ineinander fließen, das eingangs angeführte Beispiel Maus als Vorstellung sprach eine genug deutliche Sprache. Erst Linné hat durch sein dogmatisches Postulat, das freilich mehr einem doktrinären Diktate als einer induktiven Erkenntnis gleicht und das, wie ich früher nachgewiesen habe, schon von John Ray antizipiert wurde, nämlich: „*species tot numeramus, quot diversae formae in principio sunt creatae*“ den Schwerpunkt in die Art verlegt, der erst eine weitere systematische und sehr fruchtbare Arbeit ermöglichte. Aber später nahm bei Linné der Gattungsbegriff eine diametral entgegengesetzte Richtung ein: er gleicht einem Insekt, das einer Metamorphose unterworfen ist. Denn — so widerspruchsvoll es auch klingen mag — der hartnäckige Verfechter der Artkonstanz hatte später eine Theorie in der Brieftasche, der zufolge es ursprünglich nur je eine Art in jeder einzelnen Gattung gegeben habe,

<sup>1</sup> *Species* bedeutet Anblick, Blick, Gesicht, Gestalt von *specio*, *specere* = sehen.

aus der später durch Bastardierung alle die unzähligen rezenten Arten entstanden wären. Diese Theorie wurde im Jahre 1762 in seiner Disputatio „*Fundamentum fructificationis*“ vom Respondenten Gråberg öffentlich in Uppsala verfochten. Art und Gattung wären hiernach ursprünglich unter einem Begriffe zusammengefallen. „*Omnes species ejusdem generis ab initio unam constituerint speciem, sed postea per generationes hybridæ propagatæ sunt*“, so heisst es dort. „Und zwar versteht er dies so, dass die erste Art einer Gattung allen übrigen Arten der gleichen Gattung Mutter gewesen, indess Arten anderer Gattungen die Rolle des Vaters übernahmen.“ „Die Welt sei so alt, dass nahezu alle Arten gebildet seien, welche möglicher Weise entstehen konnten. Doch wäre es leicht möglich, dass es zu seiner Zeit mehr Arten gäbe als zur Zeit Bauhins“ (Nägeli, S. 6 [Note 1]).

Bei den Schmetterlingen hätte somit dieser Schöpfungsakt nur drei (!!!) Arten ursprünglich gezeitigt. Linné kannte anfangs sogar nur zwei Schmetterlingsgattungen: *Papilio* und *Phalaena*. Diese recht billige und summarische Einteilung hat Linné wörtlich vom Engländer Samuel Dale (1693) übernommen. Lassen wir die erheblich später hinzugekommene, von Réaumur benannte dritte Gattung *Sphinx* ausser Acht, so hat Linné alle Rhopalozeren und Grypozeren in die Gattung *Papilio* und alle Heterozeren (mit Ausnahme der „Sphinges“) in die andere Gattung *Phalaena* untergebracht. Dabei muss ich hervorheben, dass er mit diesen beiden Namen keine Art festhielt wie früher bei den Gattungen *Homo*, *Canis*, *Elephas*, *Bos*. Unter *Papilio* dürfte er höchstwahrscheinlich einen gemeinen Vertreter der *Vanessinae* und unter *Phalaena* fast sicher den Seidenspinner gemeint haben: hat er doch früher (1756) in einer Disputation den letzten schlechthin *Phalaena Bombyx* benannt. Nun kommt das allermerkwürdigste in Linnés Gattungsauffassung! Bei ihm gibt es keinen *Papilio*, keine *Phalaena* an und für sich., weil er für jede der beiden Gattungen eine Menge von Unterkategorien, (die sogar trinär angeführt werden wie *Papilio Eques Achivus* oder *Papilio Danaus Festivus*) wie *Phalaena Bombyx*, *Phalaena Noctua* etc., aufstellte. Über die taxonome Rangordnung dieser Unterkategorien, die dem Inhaltswerte einem Bündel von mehreren Familien entsprechen, ist sich Linné selbst im Unklaren. Bald nennt er sie. Ordo, bald Phalanx, bald Sectio aber nie Genus, und seine Nachfolger wie z. B. Barbut sogar Familia. Nicht genug des Guten. Um die Zugehörigkeit gewisser Phalänen zu einer der erwähnten Familien mnemotechnisch leicht zu fixieren, bekamen obendrein alle Arten der *Tortrices* ausnahmslos eine Endung auf *ana*, die der *Alucitæ* auf *dactyla*, die der *Tineæ* auf *ella*, die der *Pyrales* auf *alis* und schliesslich die der *Geometrae* sogar deren zwei auf *aria* und *ata*, wobei sogar solche sprachliche Monstra entstehen konnten wie *salicata*, *populata* oder *juniperata*, was wörtlich bedeuten müsste „geweidet“, „gepappelt“ oder „gewachholdert“, dass einem Humanisten ein Schauer über den Rücken läuft. Auch eine andere Endung wäre zu beanstanden wie *Gryllotalpa*, da es sich doch um einen *Talpaegryllus* handelt. Nur noch bei den *Ichneumones* hat Linné durch Anbringung der Endung *ator* — freilich nicht so konsequent wie bei den angeführten Heterozeren — ausser der Genusbezeichnung ganz versteckt im Artnamen einen dritten Genusnamen eingeschmuggelt. Aber eben diese originelle Art, mit einem Suffix am Artnamen die Gattungszugehörigkeit zu einer Gruppe zu signalisieren, scheint für die taxonome Weiterentwicklung der Nomenklatur nicht ganz ohne Bedeutung zu sein. So hat der Deutsche L. Rumbler auf dem achten Internationalen Zoologenkongresse zu Graz vor knapp 40 Jahren eine Modernisierung der antiquierten Tiernamen, gerade an die von Linné eingeführte Uniformierung der zu einer Gattungsgruppe gehörenden Artnamen anknüpfend, vorgeschlagen: jede Art sollte ausnahmslos



einen Appendix zur Festhaltung der Familie angehängt und einen Präfix zur zoogeographischen Charakterisierung des Verbreitungsareals erhalten; ähnlich empfiehlt R h u m b l e r eine Modernisierung des Gattungsnamens durch Anbringung eines Prä- und Suffixes zur mnemotechnischen Festhaltung der Ordnung- und Klassenzugehörigkeit der betreffenden Gattung. So würde *Parnassius apollo* (L.) demnach heissen *Ylparnassia aoapolloa*; diese zum alten Namen hinzugekommenen Laute oder Buchstaben sollten Insekt, Lepidopteron, Papilionide und holarktisch signalisieren. Das ist eine Totgeburt, aber gleichzeitig eine logische spitzfindige Weiterführung der L i n n é schen Benennungsmanier. Denn wir kommen heutzutage mit zwei Namen nicht mehr aus. Schlagen wir heute irgendeine zoologische Zeitschrift auf: stets begegnen wir neben der binären Bezeichnung des zu behandelnden Tieres oder der Tiergruppe noch am Kopfe der Schlagzeile des Aufsatzes die zugehörige Klasse oder Familie oder beides angegeben. Denn man kann heute keinem Zoologen zumuten, dass er aus dem Gattungsnamen eines Tieres den Rangplatz des Tieres im Systeme erkenne. Und so wie heute dieser Familienindikator unentbehrlich ist, so war zu alten Zeiten der Gattungsnamen zur Registrierung verwandtschaftlicher Zusammengehörigkeit als geniale Nothilfe eingeführt . . . und hat diesen Sinn noch bis zum heutigen Tage beibehalten. Denn rein erkenntnistheoretisch würde ein einziger Name zur Bezeichnung eines Tiers oder einer Pflanze genügen<sup>2</sup>. Alles andere ist nur Verdeutlichung, Registratur, Abstammungslehre . . . Systematik.

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<sup>2</sup> „Der Gedanke des Herrn Ehrhart, jeder Art nur einen Namen zu geben, und den Namen des Geschlechts gar nicht auszusprechen, war sehr richtig und in der Natuf gegründet, nur würde die Botanik dadurch zu sehr erschwert worden seyn.“ (Link, D. H. F., S. 61.)

## SUR LA DISCRIMINATION DES FORMES INDIGÈNES ET DES FORMES IMPORTÉES DANS LES CATALOGUES FAUNISTIQUES

Par P. Lepesme

Dans une note sur "les genres de Coléoptères importés ou acclimatés dans la faune euro-méditerranéenne"<sup>1</sup>, P. de Pey er i m h o f f propose de reléguer en fin d'énumération ou en note infrapaginale dans les Catalogues les espèces qui ne se reproduisent pas dans la région et n'y apparaissent qu'accidentellement. Il est indispensable, en effet, d'établir une discrimination entre les formes indigènes et les formes introduites, bien qu'il soit parfois malaisé, sinon impossible, d'affirmer ou d'infirmer l'indigénat d'une espèce : cas du *Glymma Candezzei* Mars., cité par De Pey e r i m h o f f, cas heureusement assez rare. Mais il y a plus. Il serait également intéressant de pouvoir distinguer, à la simple lecture du catalogue, les formes acclimatées ou en voie d'acclimatation normale à l'extérieur, de celles dont le développement ne se poursuit qu'à la faveur de conditions microclimatiques particulières (serres, entrepôts chauffés, silos, etc.). Les premières sont, en effet, susceptibles d'être considérées, avec le temps, comme partie intégrante de la faune indigène, aux yeux du chasseur, sinon du biogéographe : le Callichromine *Philematium festivum* F. est depuis si longtemps une des bêtes caractéristiques des chasses guadeloupéennes, qu'on finit par oublier son origine africaine. Les secondes, au contraire, dont la survivance dans leur nouvelle patrie est toujours précaire, ont peu de chance de se faire prendre au dehors; ce sont, pour la plupart, des formes synanthropes cosmopolites, ce qui ne signifie nullement que toutes les formes synanthropes cosmopolites doivent être rangées dans cette catégorie. Comment ne pas faire une distinction entre le *Tribolium castaneum* Hbst. ou l'*Oryzaephilus surinamensis* L. qu'on rencontre en forêt sous les écorces en divers points du globe où ils sont redevenus sauvages, et le Dermestide *Trogoderma granarium* Everts localisé, en Europe, aux atmosphères surchauffées des brasseries et malteries d'Europe centrale et d'Angleterre? En réalité, pour la faune paléarctique, la distinction entre les deux groupes revient pratiquement à séparer les formes tropicales des formes tempérées.

D'une manière générale, il semble qu'on pourrait adopter, dans les catalogues et faunes locales, le système suivant :

1° — Mentionner uniquement en note infrapaginale les espèces introduites incapables, dans l'état actuel de nos connaissances, de se reproduire dans la région considérée, même si leur introduction se répète périodiquement et fréquemment.

C'est le cas, pour la faune européenne, de la plupart des Carabiques importés, du Cossonide *Caulophilus latinasus* Say, des Scolutides du genre *Letznerella* et *Lepicerus*, de Noctuelles comme *Prodenia litura* F., de Fourmis comme l'espèce colombienne *Camponotus Bugnioni* Forel, etc.

2° — Annoter du signe <sup>xx</sup> les espèces introduites qui ne se maintiennent dans la région qu'à la faveur d'un microclimat particulier et s'avèrent incapables de se reproduire dans la nature.

J'en donnerai comme exemple des Coléoptères synanthropes tels que *Trogoderma granarium* Everts, *Rhizopertha dominica* F., *Pharaxonota Kirschi* Rtt. et des formes localisées, en Europe, aux serres chaudes comme le Phasgonuride *Tachycines anysamorus*

<sup>1</sup> Rev. fr. Ent., XII, p. 5, 1945.

Adel., la Cochenille *Aspidiotus cyanophylli* Sign., l'Aleurode *Asterochiton vaporarorum* Westw., les Colydiides *Penthelispa inexpecta* Duv. et *Philothermus Montandoni* Aubé, le Chalcidien *Isosoma orchidearum* Westw.

3° — Annoter du signe \* les espèces acclimatées ou en voie d'acclimatation.

Citons dans cette catégorie, en dehors des exemples si classiques d'espèces nuisibles bien établies comme le Doryphore, le Pou de San José, la Cochenille australienne, la Fourmi d'Argentine, etc., et de ceux non moins classiques de prédateurs ou de parasites volontairement introduits comme la Coccinelle *Rodolia cardinalis* Muls. ou le Chalcidien *Prospaltella Berlesei* How., des Coléoptères comme *Lispinus impressicollis* Motsch., *Pantomorus Fulleri* Horn, *Stenopelmus rufinasus* Gyll., *Oryzaephilus surinamensis* L., *Tribolium castaneum* Hbst., ces derniers synanthropes facultatifs qu'on eut peut-être pu autrefois classer dans la seconde catégorie.

On pourra évidemment reprocher à une telle classification d'être trop absolue pour bien s'adapter à la réalité. Il ne fait aucun doute que la position de certaines espèces est douteuse et que celle d'autres espèces, certaine actuellement, devra être modifiée par la suite. Mais toute classification n'est-elle pas trop rigide lorsqu'il s'agit de la nature? Celle qui est proposée ici n'a d'autre ambition que de réduire au minimum les erreurs faites par le biogéographe dans l'établissement de statistiques à partir des catalogues et faunes locales.

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## LES PROFITS QUE LA NOMENCLATURE ZOOLOGIQUE POURRAIT TIRER DU SCHÈME INTERNATIONAL DE TRANSLITTÉRATION APPLIQUÉ AUX NOMS CYRILLIQUES

Par *Jirí Paclt*

Non seulement dans le domaine de la documentation scientifique, mais également — et cela est essentiel pour nous — dans la nomenclature elle-même de l'histoire naturelle on rencontre très souvent des mots originellement écrits dans différents caractères non-latins. Il s'agit surtout d'un des systèmes d'écriture suivants : l'ancien alphabet grec, toutes les formes de la cyrillique moderne, les écritures chinoise et japonaise. Naturellement, il est impossible d'opérer internationalement avec un autre système alphabétique que celui en caractères latins. C'est pourquoi, hélas, nous nous réfugions dans une romanisation des mots dérivés de ces langues aux caractères non-latins. Permettez-moi, Messieurs, de présenter dans cette communication quelques observations sur l'histoire, l'état actuel, ainsi que sur l'avenir du problème de la translittération au point de vue d'un zoologiste.

Se basant sur la richesse linguistique des langues antiques, la nomenclature zoologique fut chargée, depuis quelque temps, de résoudre de nombreuses questions de translittération du grec ancien. Comme résultat de tous ces examens et considérations, les Règles Internationales de la Nomenclature Zoologique prescrivirent un article dont le texte français est le suivant;

Article 19. "L'orthographe originelle d'un nom doit être conservée, à moins qu'il ne soit évident que ce nom renferme une faute de transcription, d'orthographe ou d'impression."

Dans l'addition une recommandation a été publiée sous la forme d'un appendix "F" aux Règles Internationales, dans lequel on a indiqué comment on devrait romaniser à l'avenir les mots grecs. En effet, ce tableau de translittération n'a aucune force rétro-active; un nom qui a été donné à un certain animal sans avoir respecté les opinions que je viens de mentionner, ne peut jamais être amendé ou modifié d'après le schème recommandé. Mais on peut dire qu'en général, le tableau de romanisation grecque n'est pas ignoré dans les travaux sérieux lorsqu'il s'agit d'introduire un nom nouveau, soit générique, soit spécifique ou d'un rang inférieur (subspécifique).

La nomenclature zoologique, y compris la nomenclature entomologique, n'utilise pas seulement les richesses de la culture antique. Ce sont des noms propres ou géographiques, orientaux ou cyrilliques, qui, de nos temps, entrent dans beaucoup de dénominations zoologiques. Et, de plus en plus, on peut s'attendre à l'usage toujours croissant de travaux scientifiques publiés en l'U.R.S.S. ou en Chine. Le problème actuel est donc de romaniser les symboles non-latins d'après un schème détaillé. Il faut cependant prévenir que la norme proposée pour l'avenir doit être commune à deux champs distincts : 1) le champ bibliographique, 2) le champ nomenclatorique. Par ailleurs, il est nécessaire de chercher une norme qui pourrait satisfaire toutes les nations, en leur donnant un tableau uniforme de la romanisation. En ce qui concerne les noms orientaux, la question n'est pas encore très claire. Provisoirement les systèmes de Hepburn — pour servir à l'alphabétisation des noms japonais — et celui de Wade-Giles — pour servir à la romanisation des noms chinois — sont bien utiles

au travail du documentaliste, et peut-être même, en accord avec l'appendix "G" des Règles Internationales, au systématicien dont les explorations se sont concentrées dans la faune d'Extrême-Orient. Quoique, à proprement parler, cette matière n'appartienne plus au sujet de ma communication, je pense qu'il fallait bien en parler un peu.

Maintenant, je vais expliquer le problème de la romanisation cyrillique. Tout d'abord, je dois remarquer qu'il n'y a pas un seul alphabet cyrillique, il faut en effet distinguer plusieurs versions de la cyrillique, qui sont plus ou moins distinctes les unes des autres. C'est pourquoi il est impossible de faire usage, "en bloc", d'un seul tableau de romanisation, servant à tous les alphabets slaves cyrilliques. Les principales versions de la cyrillique moderne sont les alphabets russe, bulgare et serbe. En outre il existe encore un certain nombre d'alphabets cyrilliques, mais vraiment peu importants pour nous. Etant donné que les autres langues slaves sont caractérisées par leurs alphabets en symboles latins, il faut constater que le problème de la translittération cyrillique se réduit à la possibilité de trouver certaines relations linguistiques entre un alphabet cyrillique et un système qui lui correspond en caractères latins. Heureusement, dans la langue serbo-croate les deux systèmes, cyrillique et latin, se trouvent appliqués au même langage. Et, je n'aurais pas à faire le présent rapport, si la chose avait été résolue par ce fait. mais en réalité, le système scientifique fondé sur la pratique interalphabétique serbo-croate n'est pas encore adopté par tout le monde. Par suite, il me semble nécessaire de résumer brièvement l'histoire de la romanisation internationale des alphabets cyrilliques.

Je n'ai pas l'intention de traiter des philologues du siècle passé qui reconnurent le système tchèque des diacritiques<sup>1</sup> pour une base scientifique dans l'espace de la translittération internationale de plusieurs des langues écrites en caractères non-latins. Il est étonnant qu'une des plus précoces recommandations du système peut être trouvée chez les non-Slaves (p. ex. Kuhn et Schnorr, déjà en 1897). Plus tard, quelques périodiques de référence ont adopté ce système scientifique, surtout le "International Catalogue of Scientific Literature". La même translittération est également employée dans l'ouvrage "Periodica zoologica" par Apstein et Wasikowski, mais ce dernier tant une publication récente (1938) est donc un peu en dehors du cadre du présent paragraphe. En continuant à décrire l'évolution historique du problème, il me reste à dire que c'est un professeur italien, Enrico Damiani, qui peut être considéré comme le pionnier du système de la translittération slave scientifique : en effet Damiani a publié beaucoup d'articles sur ce sujet et ses efforts n'ont point péri.

En Italie, par exemple, le système fut introduit officiellement (1940). Il y a également lieu de mentionner un grand nombre d'autres autorités qui se sont occupées du problème de la romanisation slave internationale. Parmi elles, il faut citer les noms suivants : l'Académie des Sciences de l'U.R.S.S. représentée par Karskij, Lavrov, Ljapunov, Scerba, ainsi que le professeur hongrois Kniczsa, et d'autres encore.

Quel est le but de la translittération internationale de la cyrillique? Prenons en considération une application du système à la nomenclature zoologique : comme ailleurs la tâche est d'unifier la manière de reproduire chaque caractère cyrillique par le caractère latin équivalent. Une pareille norme internationale n'est ni difficile ni très facile à apprendre. Pour les détails je prends la liberté de renvoyer ceux qui s'inté-

<sup>1</sup> Une invention très intelligible, formulée en 1405 environ, par le plus grand réformateur de sa nation, le Maître Hus.



ressent sérieusement à la question à ma brochure en tchèque et anglais que je viens de faire circuler aux congressistes qui sont venus pour entendre ma communication<sup>2</sup>.

Citons encore quelques exemples tirés de la pratique que l'on rencontre dans la nomenclature zoologique lorsque l'on a dédié un genre ou une espèce à une localité ou à une personne dont le nom est écrit en cyrillique. Пржевальский, célèbre voyageur russe, "prêta" son nom à une espèce du cheval: *Equus przewalskii*. Conformément au schème internationale le nom devrait être orthographié "*E. prevalskiji*". Des noms tels que *Romanoffia* (insecte lépidoptère) devraient correctement être écrit "*Romanovia*", à l'instar de *Semenoviola*, un autre genre dont le nom est bien translittéré. La translittération des noms des auteurs scientifiques semble être plutôt confuse. Celui de Sugorov se trouve souvent romanisé comme Schugorow (en Allemagne), Szugorow (en Pologne), Shugoroff ou Schugoroff (en France), etc. Les noms de Jermolajev, Kozancikov, Plavilscikov, Semenov-Tjansanski, Slascevskij, Seljuzko, etc. devraient de même figurer au lieu de Ermolajew (ou Jermolaeu), Kozhantschikov, Plavilstschikow (ou Plavilstshikov), Sémenov-Tian-Chansky (ou -Shanski), Slaszevsky (ou Slastshevskij), Sheljuzhko, etc. Surtout

<sup>2</sup> Sur simple demande adressée au Secrétariat du Congrès, les personnes intéressées peuvent obtenir gratuitement un exemplaire de cette étude ("Studie o transliteraci azbuky", with an English Summary, 1946).

pour le commencement de chaque mot, où il s'agit de caractères différents, rangés dans l'alphabet séparément, il est important d'unifier la manière de translittération, si l'on veut parler toujours encore d'une documentation scientifique. En général, on peut dire que les caractères cyrilliques ч, ш, щ, ж sont remplacés dans le système scientifique romanisé par les lettres c, s, sc (st), z ; tandis que, chez différentes nations, différents systèmes conventionnels ("nationaux") de translittération attaquent l'internationalité de la nomenclature scientifique : regardons seulement un nom adjectif "*baschkiricus*". Que de variations orthographiques dans ce seul cas ! Si l'auteur du nom est un allemand, il n'y aurait pas d'objection. Dans d'autres éventualités, néanmoins, nous lirions "*bashkiricus*" (anglais), "*baskiricus*" (magyar), etc., tout cela étant mal orthographié au lieu de "*baskiricus*" (romanisation internationale).

On ne doit pas oublier de souligner que l'application des signes diacritiques, dont on fait usage dans le système international de la romanisation cyrillique, n'apporte pas de difficultés insurmontables. Il est vrai que la reproduction n'est pas souvent commode aux imprimeries des nations dont la langue ne connaît pas de diacritiques. Au contraire, il n'y pas beaucoup de langues civilisées qui les ignorent complètement. En effet les diacritiques se trouvent en espagnol (ñ, á, é . . .), suédois (ä, ö, å), danois (ø), etc., même en français (ç, ê, è . . .). Quelques uns des signes diacritiques propres à la romanisation scientifique de la cyrillique ne manquent dans aucune langue slave en caractères latins sauf dans le polonais. Les "s" ou "z" participent aujourd'hui à l'orthographe croate, finnoise, lithuanienne, ou lettone, slovaque, slovène et tchèque.

Je voudrais donc en conclusion proposer de recommander un schème de romanisation de la cyrillique comme l'appendix "H" aux Règles Internationales de la Nomenclature Zoologique. Etant donné l'existence des opinions déjà formulées dans l'appendix "G" (La Transcription des Noms géographiques et propres), il faudrait changer un peu le texte en question en y ajoutant :

"Les règles suivantes sont relatives seulement à ceux des pays qui n'ont pas d'écriture propre ou qui ne font pas usage de caractères latins, à l'exception de l'écriture cyrillique (voir appendix "H")."

Tout ce que j'ai dit sur l'usage du schème de translittération grecque, pourrait être, eo ipso, appliqué ici. C'est pourquoi je termine ma communication, en remerciant vivement tous les congressistes présents de leur attention.

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## THE IDENTITY OF APHIS TANACETI L. 1758

By H. L. G. Stroyan

*Introduction.*

An investigation of the early descriptions of *Aphis tanaceti* L. has led to the conclusion that the name is at present wrongly applied. The name *tanaceti* Linnaeus 1758 properly belongs to the species now called *Dactynotus tanaceticola* (Kalt. 1843). The species now known as *Pharalis tanaceti* (L. 1758) will have to be renamed and will revert to the genus *Metopeurum* Mordvilko 1914. I propose the name *fuscoviride* nom. nov. for *Aphis tanaceti* L. 1758 of authors but not of Linnaeus. I shall hereafter in this paper refer to this species as *Metopeurum fuscoviride* n.n. (= *tanaceti* L. 1758 auctt. nec L.).

The evidence on which I base these changes is as follows:

(1) The early descriptions.

I have investigated descriptions by all the early writers who list *Aphis tanaceti*. I arrange the most important in chronological order, with notes.

(a) Linnaeus, 1758. Syst. Nat. X, p. 452.

Cites *tanaceti* without description, and the mere note "Habitat in Tanaceto vulgari." Many species are found on *Tanacetum*, and there is no indication which is meant by this description.

(b) Linnaeus, 1761. Fauna Suecia, p. 260, no. 989.

"Habitat in Tanaceti vulgaris foliis, distincta ab Aphide viridi in caulibus Tanaceti, quae communis pluribus plantis. DESCR. Corpus rufum s. saturate ferrugineum: corniculis subfuscis, Alarum rudimenta, Antennae & Pedes pallidiora."

This is the earliest description, and minutely characterizes the *Aphis tanaceticola* of Kaltenbach.

(c) Geoffroy, 1764. Histoire des Insectes, p. 496.

"*Aphis tanaceti fusca*, abdomine nigro caeruleo antico viridi." This description is not easy to recognise, but may refer to *Brachycaudus cardui* (L.). It is repeated by

(d) Fabricius, 1781. Species Insectorum, II, p. 387.

It is in any case a different insect from *tanaceti* L. 1758 & 1761.

(e) Linnaeus, 1787, Syst. Nat. XII, p. 516.

"... rostfarbig, mit blassen Fühlhörnern und Füßen, dann braunen Hörnern oder Fortsätzen am hintern Körper." This is a reaffirmation of the description in Fauna Suecica, and clearly refers to *Aphis tanaceticola* Kalt.

(f) Schrank, 1801, Fauna Boica, II, p. 123.

Describes *Metopeurum fuscoviride* n.n. under the name *tanaceti*; i.e. a species with black legs, antennae and cornicles.

(g) Risso, 1826. Hist. Nat. des principales productions de l'Europe Meridionale, V, p. 217.

Names but does not describe a species *Pharalis tanaceti* Leach.

(h) Kaltenbach, 1843, Monog. der Pflanzenläuse, 47.

(i) Koch, C. L., 1854, Die Pflanzenläuse, Aphiden, 156.

Both authors describe *Metopeurum fuscoviride* n.n. accurately, but Kaltenbach's *alatae* are a different species.

(2) Modern papers.



(a) Mordvilko, 1914—1919. Faune de la Russie, I, livr. 1—2.

Mordvilko erects two new genera, *Metopeurum* and *Paczoskia*, in his key to the Macrosiphina in livr. 1, pp. 67 and 63 respectively. No genotypes are cited in this key, but figures of the head and posterior end of *Metopeurum tanacetii* (L.) (*M. fuscoviride* n.n.) on pp. 50 and 56 are sufficient to establish *tanacetii* (L.) of Mordvilko as the type of *Metopeurum*. *Paczoskia*, however, in the absence of any such inferential type-fixation, remains a genus dubium until described and assigned a genotype *paczoskii* Mordv. on p. 330 or livr. 2 in 1919.

(b) Börner, C., 1930. Arch. f. klass. u. phylog. Ent., I, p. 163.

Börner interprets *tanacetii* Leach (vide [g]) as being identical with *tanacetii* Linnaeus 1758, and thereby validates *Pharalis* Leach 1826, by giving it a genotype *tanacetii* L. 1758 (Lambers, 1939). He also suggests that *Paczoskia* Mord. 1919 is a synonym of *Metopeurum* Mordv. 1914, and of *Pharalis* Leach 1826, with which he replaces both Mordvilko's generic names.

(c) Hille Ris Lambers, 1939, Temminckia, IV, p. 128 et seq.

Fully describes *Pharalis tanacetii* (L. 1758) auctt. (= *Metopeurum fuscoviride* n.n.); and says in his discussion of the genus: "Possibly *Paczoskia* Mordv. 1914, genotype *paczoskii* Mordv., is a synonym of this species as Börner suggests, though Nevsky (1929) places it in *Macrosiphum*."

#### *Discussion of the evidence.*

(1) The early descriptions.

First of all it is clear that Linnaeus intended his *tanacetii* to represent a rust-red species with pale or paler legs and antennae and brown or infuscate cornicles, living on the leaves of Tansy rather than the stems. This species is without doubt that subsequently described by Kaltenbach in 1843 as *Aphis tanaceticola*.

Secondly, Schrank and subsequent authors from Kaltenbach and Koch down to the present day recognised as *tanacetii* L. 1758 a second species with blackish legs, antennae and cornicles, and a large dark dorsal abdominal blotch. It is this species which I now name *fuscoviride* n.n. in the absence of any other valid name.

(2) Börner's interpretation of Leach's and Mordvilko's names.

(a) *Pharalis* Leach 1826.

Börner assumes that *tanacetii* Leach = *tanacetii* L. 1758. If this is so, following the application of *tanacetii* L. 1758 to *tanaceticola* Kalt. 1843, *Pharalis* Leach becomes a synonym of *Dactynotus* Rafinesque 1818. If it is not so (which is the more satisfactory assumption) *Pharalis* Leach is a nomen nudum and loses all status.

(b) *Metopeurum* Mordv. 1914 and *Paczoskia* Mordv. 1919 (or 1914).

Mordvilko's keys and descriptions suggest that a considerable stretch of the imagination is required to make *paczoskii* Mordv. 1919 congeneric with *fuscoviride* n.n. and *enslini* Börner 1933. The cauda and apical structure of the siphunculi seem very similar, but *paczoskii* has a considerable frontal emargination and much longer siphunculi, and its foodplant, *Echinops ritro*, is not a close relative of *Tanacetum*. Mordvilko also says of *Paczoskia* that the apical rostral joint is stiletto-shaped, a feature typical of Anthemideae-infesting genera, and particularly among the Macrosiphini of *Macrosiphoniella* Del G. This feature is not present appreciably in *Metopeurum* Mordv. Further, *Echinops* is not a genus of Anthemideae, so that the stiletto-like rostrum in *Paczoskia* may indicate a true affinity with *Macrosiphoniella*, and not merely a convergence. This is also suggested by Mordvilko's figure of the aptera of *Paczoskia*,

which appears to possess crescentic antesiphuncular sclerites of a type found in *Macrosiphoniella*, but not in *Metopeurum*. On the whole, its segregation into a separate genus seems to be justified.

Even if this is not so, however, *Paczoskia* should sink as generic name rather than *Metopeurum*, since it was not validated by type-fixation till 1919, while the genotype of *Metopeurum* can be recognised from 1914. Therefore *Metopeurum* Mordv. 1914 stands as the first available name for *Pharalis* Leach of Börner (nom. nud. or misapplied).

(c) *paczoskii* Mordv. 1919.

Hille Ris Lambers' remark "Possibly . . . *P. paczoskii* Mordv. is a synonym of this species [*Pharalis tanacetii* (L. 1758) auctt.] as Börner suggests" is presumed to be a misprint or lapsus calami; since Börner does not refer to a specific identity, and in any case *paczoskii* Mordv. and *fuscoviride* n.n. are totally distinct, so far as can be seen from Mordvilko's figures and descriptions.

#### Summary.

The following nomenclatural changes are required to correct the existing inaccurate application of *Aphis tanacetii* L. 1758;

(1) Genus DACTYNOTUS Rafinesque 1818 (genotype *rudbeckiae* Fitch as *D. hieracium-paniculatum* Raf., by designation of Börner, 1930)

(Syn. ? PHARALIS Leach 1826, but better regarded as nomen nudum)

Species *tanacetii* (Linnaeus 1758) nec auctt. divers.

syn. *tanaceticola* (Kalt. 1843)

(? *tanacetii* (Leach 1826), but better regarded as nomen nudum.)

(2) Genus METOPEURUM Mordvilko 1914 (genotype *Aphis tanacetii* L. 1758 auctt. div. nec Linnaeus)

(Syn. ? PACZOSKIA Mordvilko 1914 (genotype and sole sp. *paczoskii* Mordv. 1919)

Species 1. *fuscoviride* mihi, nom. nov. for

*tanacetii* (L. 1758) auctt. nec L. 1761 (genotype)

2. *enslini* (Börner 1933)

3. ? *paczoskii* (Mordvilko 1919).

The name *fuscoviride* has been assigned to *tanacetii* auctt. nec L. 1761 in reference to a recently detected colour dimorphism in this species, concerning which a note is in course of preparation.

The writer's best thanks are due to Dr. Hille Ris Lambers for some stimulating and pertinent criticism; to Dr. J. Smart for information on the taxonomic issues involved; and to the Agricultural Research Council for supplying the research grant which enabled this enquiry to be carried out.

#### REFERENCES.

As all the relevant sources of information have been listed in tabular form and chronological order in the text, no separate bibliography is appended.

## SECTION XI

## ZUR PHÄNOLOGIE EINIGER NEOBISIUM-ARTEN (PSEUDOSCORP.)

Von M. Beier  
(Mit 3 Diagrammen)

Abgesehen von den biologischen Beobachtungen an Cheliferiden und Chernetiden, die Kästner, Kew, Örösi-Pal, Schlottke, Strebel und Vachon publizierten, wissen wir über die Lebensweise der Pseudoscorpioniden noch recht wenig. Besonders über die Biologie der verborgen am Boden oder in der Erde lebenden Chthoniiden und Neobisiiden ist noch so gut wie nichts bekannt. Es erscheint mir daher jeder Beitrag, der uns hierüber Aufschluss gibt, willkommen. Deshalb entschloss ich mich, die mir auf Grund eines reichen Materiales zugänglichen Daten über die Phänologie, also das jahreszeitliche Auftreten der verschiedenen Entwicklungsstadien dreier *Neobisium*-Arten und dessen Abhängigkeit von der Höhenlage bekannt zu machen. Es handelt sich um die häufigsten einheimischen Arten, nämlich *Neobisium muscorum* (Leach), *N. fuscimanum* (C. L. Koch) und *N. sylvaticum* (C. L. Koch), von denen mir ein für statistische Zwecke ausreichendes Material zur Verfügung stand. Dieses Material stammt durchwegs aus dem östlichen Teile der Ostalpen und dem Voralpengebiet, also aus einer geographischen und mikroklimatischen Einheit, so dass die einzelnen Fänge unter Berücksichtigung ihrer Höhenlage diesbezüglich miteinander vergleichbar sind, und wurde grösstenteils von H. Franz, H. Strouhal und mir zusammengetragen. Eine Fehlerquelle liess sich allerdings nicht ausschalten, nämlich die Verschiedenheit der einzelnen Biotope mit ihren mikroklimatischen Besonderheiten, die im allgemeinen beim Aufsammeln nicht ohne weiteres exakt erfassbar sind, die Entwicklungsgeschwindigkeit aber zweifellos bis zu einem gewissen Grade beeinflussen. Allerdings schafft hier die grosse Zahl der Fänge wiederum einen weitgehenden Ausgleich, so dass die gefundenen Durchschnittswerte Anspruch auf Allgemeingültigkeit erheben können. Von der grossen Masse des Materials kamen für den vorliegenden Zweck von vornherein nur solche Fänge in betracht, die entweder gravide Weibchen oder eines der drei Entwicklungsstadien (Proto-, Deutero- bzw. Tritonymphen) enthielten. Leider wurde die Zahl dieser Fänge auch noch dadurch verringert, dass viele wegen fehlender oder ungenügend genauer Funddaten (Datum und Meereshöhe) als unbrauchbar ausgeschieden werden mussten. Es verblieb aber trotzdem noch ein reiches Material, das recht interessante Aufschlüsse zu liefern vermochte.

Es soll nun versucht werden, die Phänologie der eingangs erwähnten Arten an Hand von graphischen Darstellungen der Geländehöhen-Jahreszeiten-Korrelation zu analysieren. Für die Errechnung der Mittelwertskurven und die Herstellung der Graphika bin ich Herrn Dr. O. Scheerpeltz zu grossem Dank verpflichtet. Die Graphika sind so beschriftet, dass sich eine weitere Erläuterung erübrigt. Es muss nur erwähnt werden, dass in der Darstellung den Geländehöhen gegenüber dem zeitlichen Ablauf das doppelte Gewicht beigemessen wurde, um die Mittelwertskurven deutlicher zum Ausdruck zu bringen.

Betrachten wir zunächst einmal *Neobisium muscorum* (Leach), von dem mir über 220 verwertbare Fänge mit Nymphenstadien bzw. graviden Weibchen aus Gelände-

höhen von 200 bis 2400 m vorlagen, so fällt in den tiefer gelegenen Biotopen auf den ersten Blick die Häufung der frühen Entwicklungsstadien einerseits in den Frühlings- und Frühsommermonaten (April bis Juni), andererseits in den Spätsommermonaten (August bis Oktober) auf (Fig. 1). Die Art hat also offensichtlich hier *zwei Fortpflanzungsperioden*, deren *erste* im März beginnt, hier auch bereits ihr Schwergewicht erreicht und bis Anfang Juni dauert. Die ersten Protonymphen dieser Fortpflanzungsperiode treten schon im März auf, häufen sich aber erst im April und Mai.

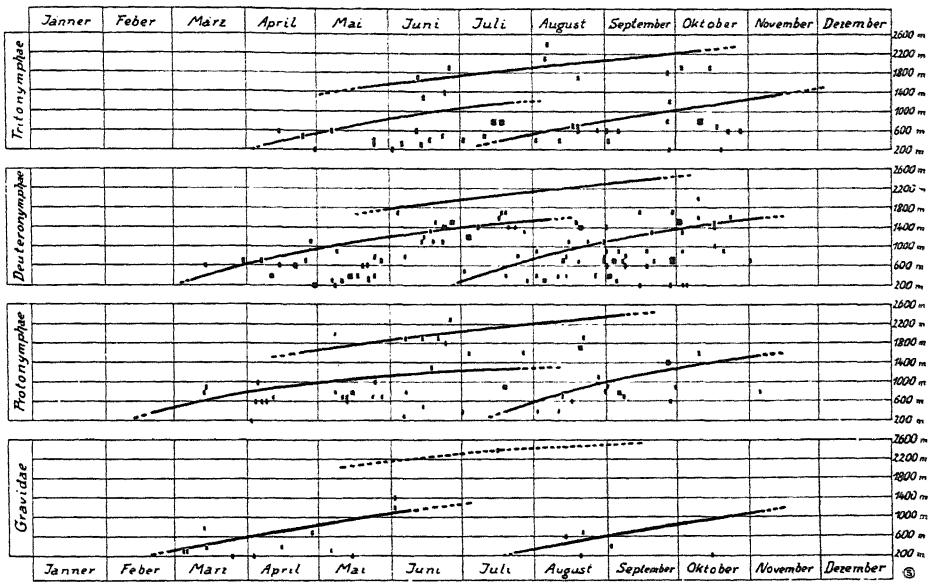


Fig. 1. Geländehöhen-Jahreszeiten-Korrelation der Entwicklung von *Neobisium muscorum* (Leach) im Ostalpengebiet. Eingetragen sind die einzelnen Fänge von Nymphenstadien oder gravider Weibchen ohne Rücksicht auf deren Individuenzahl. Gestrichelte Mittelwertskurven sind extrapoliert.

Auch vereinzelt Deuteronymphen sind bereits im März an günstig gelegenen Biotopen festzustellen, ihr massiertes Auftreten erfolgt jedoch erst in den Monaten April bis Juni. Von Tritonymphen wurden die ersten Exemplare im April festgestellt; sie häufen sich im Juni und Juli. Die *zweite* Fortpflanzungsperiode beginnt Ende Juli oder Anfang August und dauert bis in den Oktober. Ihre Protonymphen treten im August, ihre Deuteronymphen im August und September massiert auf, letztere sind aber auch noch im Oktober häufig anzutreffen. Vermutlich häuten sich alle Tritonymphen auch dieser Fortpflanzungsperiode noch vor Eintritt des Winters zur Imago. Sie dürften aber erst im Laufe des nächsten Sommers ihre volle Geschlechtsreife erlangen und somit erst wieder einer Herbstgeneration den Ursprung geben. Die Frühjahrsgeneration hingegen stammt wahrscheinlich von Müttern, die der vorjährigen Frühjahrsgeneration angehörten und entweder noch im Herbst, vermutlich aber erst im März befruchtet wurden. Diese Mütter schreiten dann im Spätsommer nochmals zur Fortpflanzung, wie auch die Herbstgeneration wahrscheinlich im übernächsten Frühjahr eine zweite Fortpflanzungsperiode erlebt. Man kann also bei den beiden Entwicklungsreihen oder Phasen eines

Sommers nur bedingt von zwei Generationen sprechen, da sie zum Grossteil aus zwei Fortpflanzungsperioden derselben Mütter hervorgehen und nur zum Teil von Müttern verschiedener Fortpflanzungsperioden stammen. Dass die Frühjahrsreihe schon im Hochsommer fortpflanzungsfähig wird, dürfte wenigstens im Ostalpengebiet, wenn überhaupt, nur ausnahmsweise an besonders günstigen Biotopen vorkommen. Im allgemeinen liegt jedoch hier das Auftreten der Tritonymphen der Frühjahrsphase so spät (Juni, Juli), dass diese Tiere im gleichen Sommer für das Hervorbringen einer zweiten Generation nicht mehr in betracht kommen. Die Lebensdauer der Tiere erstreckt sich also wenigstens über zwei Jahre, vermutlich sogar über ein längere Zeitspanne, während welcher sie zumindest zweimal zur Fortpflanzung schreiten.

Auffällig ist ferner die verschiedene *Entwicklungsgeschwindigkeit* der beiden Phasen, die im Verlauf der Mittelwertskurve sehr gut zum Ausdruck kommt. Während sich nämlich die Frühjahrsphase verhältnismässig langsam entwickelt und bis zur Erreichung des adulten Stadiums etwa 4 Monate benötigt, verläuft bei der Herbstphase die Entwicklung wesentlich schneller und ist schon in etwa 3 Monaten abgeschlossen. Es ist dies auch ohne weiteres verständlich, weil ja die Entwicklung der jungen Nymphen der Frühjahrsphase noch in die im allgemeinen kühlen Monate März, April und Mai fällt und somit verzögert wird, wogegen die jungen Stadien der Herbstphase sich im heissen August und meist auch noch warmen September wesentlich schneller entwickeln können. Auch die Ernährungsbedingungen dürften für die Spätsommerphase günstiger sein als für die Frühjahrsphase, weil zu dieser Zeit die obersten Erdschichten besonders reich an kleinen Insektenlarven sind.

Das bisher Gesagte gilt im Ostalpengebiet bis zu Meereshöhen von etwa 1600 m. Darüber hinaus, also in alpinen und hochalpinen Lagen, hat *Neobisium muscorum* nur mehr eine Fortpflanzungsperiode. Diese fällt je nach der Geländehöhe und Lage des Biotops in den Juni oder Juli, unter besonders günstigen Umständen (Südlage an Hängen) ausnahmsweise schon in den Mai. Proto- und Deuteronymphen treten hier im Juni und Juli, Tritonymphen meist erst im August auf. Die Entwicklungsgeschwindigkeit ist in alpinen und hochalpinen Lagen annähernd die gleiche wie bei der Frühjahrsphase tieferer Lagen, also langsamer als bei der Herbstphase des Voralpengebietes. Es ist dies verständlich, wenn man die starken täglichen Temperaturschwankungen im Hochgebirge und das dadurch verhältnismässig tief liegende Temperaturmittel berücksichtigt, das auch bei einem niedrigen Schwellenwert eine Verzögerung der Entwicklung bewirken muss. Die vielfach vertretene Ansicht, dass die Entwicklung des Tierlebens im Hochgebirge infolge der kurzen zur Verfügung stehenden Zeit sich gedrängt und explosionsartig mit steiler Entwicklungskurve vollzieht, findet also hier keine Bestätigung. Freilich reicht auch hier der Sommer trotz seiner Kürze für den Ablauf der Entwicklung bestimmter Arten hin. Wäre das nicht der Fall, so könnten die betreffenden Arten eben nicht in diesen Höhenlagen leben und würden hier fehlen. Die Entwicklungsgeschwindigkeit an sich wird jedoch durch das Höhenleben nicht beschleunigt, sondern im Gegenteil verzögert.

Ähnlich verhält sich *Neobisium fuscimanum* (C. L. Koch), von dem mir allerdings nur 44 verwertbare Fänge vorlagen, die aber immerhin genügen, um die charakteristischen Züge der Phänologie festzulegen (Fig. 2). Auch diese Art hat eine Frühjahrs- und eine Hochsommerphase, die sich jedoch auf einen kürzeren Zeitraum zusammendrängen, so dass die Entwicklungskurven steiler verlaufen als bei *N. muscorum*. Es hängt dies wohl damit zusammen, dass *N. fuscimanum* vorwiegend eine Art des südöstlichen Europa und als solche wärmeliebend ist. Sie erreicht nördlich in Schlesien, westlich

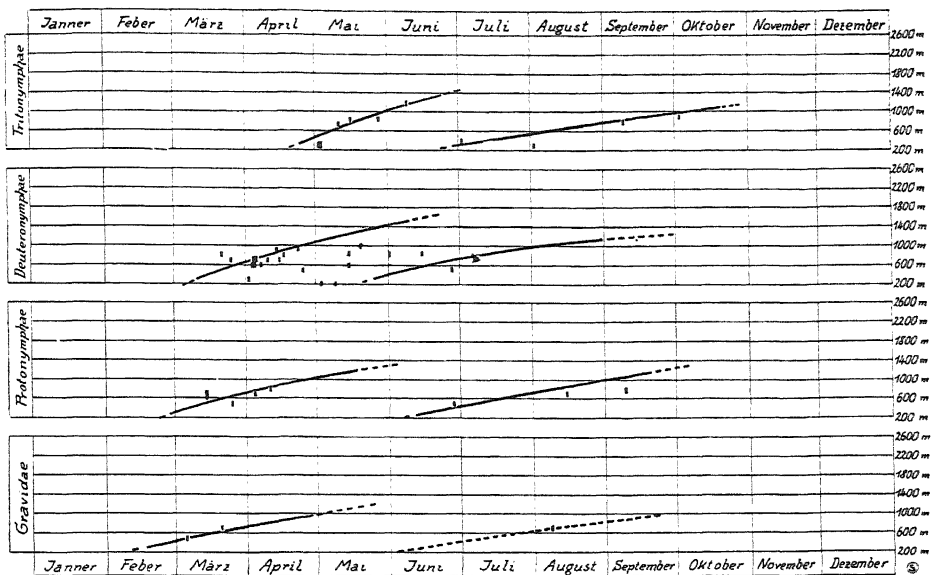


Fig. 2. Geländehöhen-Jahreszeiten-Korrelation der Entwicklung von *Neobisium fuscimanum* (C. L. Koch) im Ostalpengebiet. Sonst wie Fig. 1.

im Vogtland und in Bayern ihre Verbreitungsgrenze, umgreift die Zentralkette der Ostalpen und steigt in den Voralpen keinesfalls höher als 1200 m, bleibt also innerhalb des Buchengürtels. Deshalb fehlt ihr auch die einphasige Hochgebirgsform. Die erste Fortpflanzungsperiode fällt in den März. Protonymphen treten im März und Anfang April, Deuteronymphen von Ende März bis in den Juni mit einer Häufung im April auf. Tritonymphen sind von Mai bis Juni festzustellen. Im Juli und August kann eine zweite Fortpflanzungsperiode stattfinden, zu der jedoch anscheinend nur wenige Weibchen schreiten, denn in den Spätsommermonaten sind Nymphenstadien stets nur ganz vereinzelt zu finden. Es scheint demnach nur an klimatisch besonders günstigen Biotopen zu einer zweiten Fortpflanzungsperiode im Hochsommer zu kommen. Beide Phasen schliessen ihre Entwicklung in knapp vier Monaten ab. Soweit die spärlichen Funde im Spätsommer einen Schluss zulassen, unterscheiden sich die beiden Phasen in ihrer Entwicklungsgeschwindigkeit nur unwesentlich. Im Gegensatz zu *muscorum* sind Ende Oktober und im November keine Nymphenstadien mehr zu finden.

Von *Neobisium sylvaticum* (C. L. Koch) schliesslich lagen mir 80 verwertbare Fänge vor. Es sei hier gleich vorausgeschickt, dass es sich bei „*Microbisium dumicola* (C. L. Koch)“ um nichts anderes handelt, als um die Nymphenstadien von *Neobisium sylvaticum*, die merkwürdigerweise nicht nur habituell von den adulten Tieren ungewöhnlich stark abweichen, sondern sich auch — wenigstens in den späteren Entwicklungsstadien — mit Vorliebe mehr oder weniger hoch im Geäst dicht stehender junger Nadelbäume aufhalten, von wo sie häufig geklopft werden können. Sie scheinen in diesem für eine *Neobisium*-Art ungewöhnlichen Biotop der Blattlausjagd zu obliegen. *Microbisium dumicola* gehört also in die Synonymie von *Neobisium sylvaticum*.

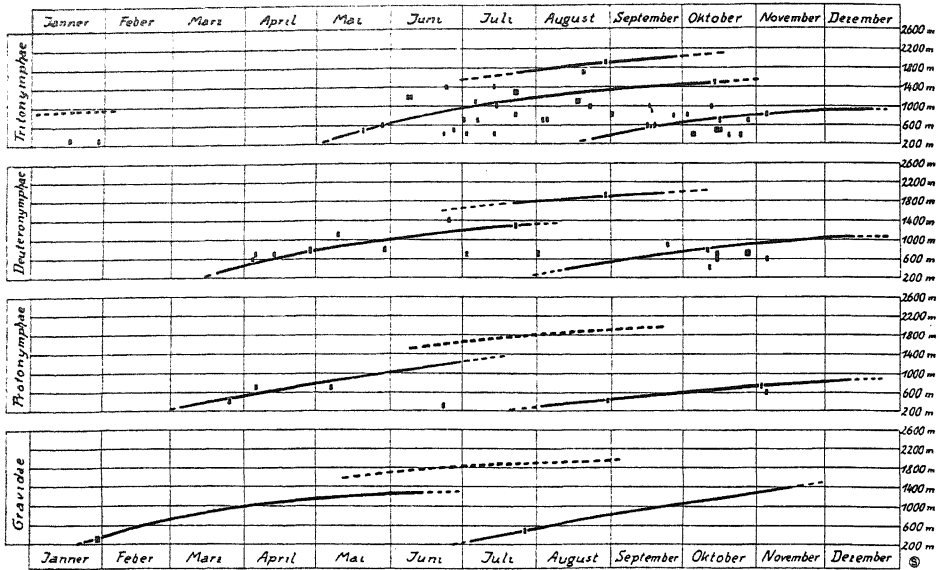


Fig. 3. Geländehöhen-Jahreszeiten-Korrelation der Entwicklung von *Neobisium sylvaticum* (C. L. Koch) im Ostalpengebiet. Sonst wie Fig. 1.

Auch diese Art hat eine Frühjahrs- und eine Spätsommerphase (Fig. 3). Erstere setzt jedoch früher ein als bei den bisher besprochenen Arten. Man findet nämlich gravide Weibchen schon im Jänner. Es steht damit ausser Zweifel, dass deren Befruchtung bereits im vorigen Herbst erfolgt ist. Protonymphen treten im März, Deutonymphen im April und Tritonymphen im Mai auf, doch häufen sich letztere erst im Juli. Die Geschlechtsreife dieser Phase tritt sicher nicht vor dem Herbst ein. Im Juli hat die Art eine zweite Fortpflanzungsperiode, deren Protonymphen im August erscheinen. Die Deutero- und Tritonymphen dieser Spätsommerphase sind im September und Oktober zu finden. Wenigstens ein Teil dieser Tritonymphen erreicht erst im nächsten Frühjahr das adulte Stadium, denn sie können überwintend angetroffen werden. Mit ziemlicher Sicherheit ist anzunehmen, dass diese Spätsommerphase erst im nächsten Sommer geschlechtsreif wird und zur Fortpflanzung schreitet. Es tritt also hier besonders deutlich zutage, dass die Nymphenentwicklung viel zu lange dauert, um zwei Generationen im Jahr zu erzielen. Auch die verschiedene Entwicklungsgeschwindigkeit der Frühjahrs- und Hochsommerphase, die bereits bei *N. muscorum* festgestellt wurde, springt hier in dem verschieden steilen Verlaufe der Mittelwertskurven wiederum ins Auge. Während nämlich die Frühjahrsphase zur Erreichung des tritonymphalen Stadiums vier bis fünf Monate benötigt, hat die Hochsommerphase diese Entwicklung bereits in etwa 3 Monaten abgeschlossen.

Der Zweiphasenzyklus ist auch bei *N. sylvaticum* auf Geländehöhen bis zu etwa 1500 m beschränkt. Die Art dringt aber im Gebirge auch in grössere Höhen vor, obzwar sie als typisches Waldtier im Gegensatz zu *muscorum* den Latschengürtel nach oben nicht verlässt. Ihre oberste Verbreitungsgrenze liegt also maximal bei 1800 bis 1900 m. In Höhen über 1500 oder 1600 m, also über der Waldgrenze, hat sie ebenso

wie *muscorum* nur eine Fortpflanzungsperiode. Deutero- und Tritonymphen treten hier erst im August auf. Die Entwicklungsgeschwindigkeit in der subalpinen Region entspricht ungefähr derjenigen der Frühjahrsphase tieferer Lagen, ist also auch hier wieder gegenüber der Spätsommerphase des Waldgürtels deutlich verlangsamt.

Fasst man die Ergebnisse dieser kleinen Studie nochmals kurz zusammen, so lässt sich verallgemeinernd feststellen, dass die *Neobisium*-Arten bei einer Lebensdauer von wenigstens zwei, vermutlich sogar mehr Jahren zumindest zweimal zur Fortpflanzung schreiten. In Mitteleuropa verläuft die Nymphenentwicklung so langsam, dass es im Laufe eines Jahres nicht zur Bildung zweier Generationen kommt. Wohl aber treten bis in Höhen von 1500 oder 1600 m zwei Phasen im Laufe eines Sommers auf. Diese gehen teils auf zwei Fortpflanzungsperioden eines Weibchens zurück, teils haben sie Weibchen vorjähriger Phasen zu Stammmüttern. Die Entwicklungsgeschwindigkeit der Frühjahrsphase ist langsamer als die der Spätsommerphase. In der subalpinen und alpinen Region, also in Höhen über 1600 m, haben die Neobisien nur eine Fortpflanzungsperiode im Hochsommer. Die Entwicklungsgeschwindigkeit der Nymphen entspricht hier ungefähr derjenigen der Frühjahrsphase tieferer Lagen, ist also gegenüber der Spätsommerphase des Waldgürtels und der Ebene verzögert.

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## SOME ACAROLOGICAL RESULTS OF THE NETHERLANDS CHIROPTEROLOGICAL RESEARCH

(Chiropterological Notes No. 26)<sup>1</sup>

By G. L. van Eynhoven

The chiropterological research in the Netherlands was initiated in the year 1937 by the 2 brothers P. J. and L. Bels, stimulated by the investigations of Eisentraut, who made a beginning in Germany at an earlier date. Shortly after they got the cooperation of Ir. D. C. van Schaik, whilst I myself joined the group as an acarologist in order to study the mites living on the bats.

This chiropterological research as such has for its object to study the migration and the geographical distribution of the bats. To that end all animals found are controlled and provided with a special small aluminium ring with a number, as far as they do not yet bear such a mark from a previous occasion.

During the last 12 years many thousands of bats have passed through our hands and it was a good occasion to examine them at the same time for epizoa. Besides acari we also found *Nycteribia*'s, fleas and *Cimex*; I shall restrict myself here to the mites.

As practically no animals are killed, the greater part of examinations has been made on the living bats with the limited light of a lamp. This is not very beneficial to the discovery of the smaller parasites, especially of those living between the body-hairs, but the rarity in our country of most species of bats, as well as the interest of the proper chiropterological research had to turn the scale. It must be added, however, that so far as I had dead animals at my disposal, the results have been very meagre.

In the Netherlands we have 14 species of bats, divided over the following genera: *Rhinolophus* (2), *Plecotus* (1), *Barbastella* (1), *Pipistrellus* (1), *Eptesicus* (1), *Nyctalus* (1) and *Myotis* (7). Rather little is known about the distribution in summer, as many species seem to pass this period outside our frontier. Such species are only met with during winter when they hibernate in our country, especially in the subterranean galleries of South Limburg, the most Southern part of the Netherlands, situated between the territories of Belgium and Germany. Twelve species are hibernating there.

In summer the most occurring species are *Nyctalus noctula*, which prefers hollow trees, and, less frequent, *Eptesicus serotinus* and *Pipistrellus pipistrellus*.

### *Spinturnix*.

The species of the genus *Spinturnix* belong to the most common, and at the same time the most striking of the epizoa, as they are rather large and use to walk about on the chiroptagium. The confusion in literature has not yet enabled us to definitely classify all the animals collected. As a remarkable species I should like to mention here *Spinturnix plecotinus* (C. L. Koch III. 1839) of *Plecotus auritus* which possesses on the front margin of its dorsal shield 3 pairs of hairs, whereas all other species of the genus have 4 pairs of these.

As nova species I could describe *Spinturnix oudemansi* (v. Eynh. V. 1941) from the Greater Horseshoe Bat *Rhinolophus ferrum equinum*. This *Spinturnix oudemansi*

<sup>1</sup> List of 22 titles in No. 22 (Natuurhist. Maandbl. 1942) No. 23 in Tschr. v. Ent. 1943, 25 1945 (1947) No. 24 in Ent. Ber. 1946. Nos. 9, 15, 16, 18, 20, 23, 24, 25 are acarological.

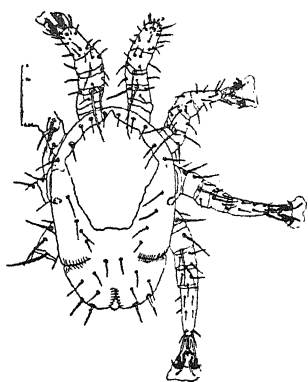


Fig. 1. *Spinturnix oudemansi*  
with dorsal shield.

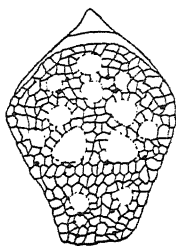


Fig. 2. *Labidocarpus belsorum*.



has a striking resemblance with *Spinturnix euryalis* (G. Can. IX. 1884) of *Rhinolophus euryale*, described from Southern Europe. Careful comparison with material of the latter species, which I received from the British Museum, learnt that we have to do with 2 distinct species. On that occasion the confusion could also be removed that existed on account of the supposed synonymy of *Spinturnix euryalis* and *Periglischrus interruptus*. These 2 mites have no resemblance whatever, but they had been confused as Canestrini gave no figures in his description, as Berlese in his plates confounded the 2 species, and as Vitzthum overlooked a publication of Stanley Hirst.

#### *Periglischrus*.

Also the *Periglischrus* was discovered by us on the *Rhinolophus*. Whilst the ♀♀ use to stick to the uropatagium, the ♂♂ can also be found elsewhere on the host.

On account of priority the mites of the Horseshoe Bat have at all events to be named *Periglischrus rhinolophinus* (C. L. Koch X. 1841), and not *Periglischrus interruptus* (Klti 1856), but I am not yet convinced that *Periglischrus interruptus*, described from other bats than *Rhinolophus ferrum equinum* is synonymous.

#### *Notoedres*.

A very interesting species, *Notoedres vanschäiki* (v. Eyn d h. 22. V. 1946), new for science, was at first found on *Nyctalus noctula*, and later on *Eptesicus serotinus*. The ♀ lays its periolated eggs in a group of 30—50 pieces and remains sitting in their centre. Thus one finds on the bat, and especially at the margins of the wings, such small heaps of eggs which are not covered whatsoever. This is a big difference with the well-known *Nycteridocoptes poppei* (Oudms. III. 1898) which specializes on *Myotis myotis* and which was repeatedly found by us. The *Nycteridocoptes* ♀ is laying non-pedunculate eggs and is sitting together with them under the epidermis thus causing a small pustule. *Notoedres vanschäiki*, by its particularity, is therefore much more striking the eye.

The larvae, nymphae and mares are walking free on the bat and are difficult to be found on account of their small size.

It appeared that the 3rd pair of legs of the embryo can occur in 4 different situations

within the egg. Most probably this will partially be connected with the development and growth of the embryo.

*Notoedres vanschaiki* can easily be reared on the living host; its attack is generally inoffensive and does not cause a real itch as is the case with other mammals.

#### *Macronyssus.*

The nomenclatural confusion of the *Macronyssus* species is still greater than with *Spinturnix*. We have collected many specimens in various species, but I should like to abstain from mentioning names.

#### *Argas.*

On *Pipistrellus pipistrellus* we stated *Argas pipistrellae* (Audouin VI. 1832). *Argas testudo* (Rossi 1790) (= *vespertilionis*) was not found by us. After comparing our specimens with slides from the collection of Oudemans, I am convinced that there really exist 2 distinct species.

#### *Ixodes.*

I am convinced that *Ixodes vespertilionis* (C. L. Koch IX. 1841) is a collective species which falls to some other species. It is the question how these species have to be named on account of publications in ancient days.

#### *Otonissus.*

Small orange mites are frequently met with on the ears and sometimes on the wings of various bats. They are of the type "*Otonissus aurantiacus*" (Kolenati 1856), but our present knowledge does not yet permit to give a definite name.

#### *Labidocarpus.*

The only species found was a nova species which I called *Alabidocarpus belsorum* (v. Eyndh. 15. VI. 1940). Whereas all other species of this genus are living on Rhinolophidae, our specimen was collected on *Myotis myotis*.

#### *Myobia.*

A fine species was collected from *Pipistrellus pipistrellus*. At first it seemed to be new for science. Repeated comparison with details in literature however learnt that it must be identical with *Myobia etheldredae* (Perkins 1925) Radf. VIII. 1941, originally published by Perkins as a species of Anoplura. The error was discovered by Radford who gave a new figure. Both authors, however published descriptions and figures which must be called insufficient. Mr. Browning of the British Museum was so kind as to compare my drawing with the type specimen and could confirm the identity. We also found the nympha masculina which so far was unknown.

### GENERAL CONCLUSIONS.

In the foregoing I have avoided as much as possible to enter into too many details. Rather should I state here some of our general experiences during this research.

Oudemans liked to proclaim the theory, and he attached great value to it, that each species of animals has its own distinct epizoa, and that conversedly also an epizoon is limited to one single, or at most a few hosts. Our results, as a whole, have

proved him right. One should not exaggerate, for there are cosmopolites, but it is a fact that many species show a high grade of specialisation. That this is not merely a coincidence may be shown by the following observation:

In a mixed lying-in room where the bats drop their young, *Rhinolophus ferrum equinum* and *Myotis emarginatus* were hanging pell-mell and against each other. Mr. P. J. Bels collected mites from both species which he kept strictly separated in 2 glass tubes, and with the exception of one larva one tube only contained *Spinturnix oudemansi* from *Rhinolophus* and the other the *Spinturnix* of *Myotis emarginatus*.

We are strongly under the impression that the number of epizoa on the bats is larger in summer than in winter. This is a pity, as most of the species of bats can be found in the Netherlands during their hibernation only. Our summer captures, however, point to this opinion and the much reduced corporal functions attended with a strongly cooled body during hibernation, are making this easily comprehensible. Most probably the epizoa will be present then in the egg-phase, or they will at least propagate slower. *Spinturnix oudemansi*, for instance, is practically never found by us during winter, whereas it is common in summer. On *Barbastella* we never found a *Spinturnix*, whereas it has been described already by Kolenati, whilst I received specimens from Germany collected by K. W. Neumann in the summer months.

Bats have the name to be full of vermin. Our experiences are otherwise. Excesses are rare, even in summer. Yet in some cases the attack can be too heavy. Once I received a *Pipistrellus pipistrellus* in rather bad condition with some 2000 specimens of so-called *Otonissus* sticking to it, which I suppose will not have been strangers to same.

A difficulty is the problem to keep bats alive in captivity in order to rear in this way the epizoa. Bats are very tender and subject to outward influences. If one succeeds, however, in keeping the host alive, one can also keep the acari propagating on it. So, for instance, I had a number of months an *Eptesicus serotinus* on which 3 species of acari were thriving so abundantly that from time to time I was compelled to remove part of them.

In this short space of time I have only been able to give a summary review of the results which we had so far with our chiropterological research. I hope that it will be clear to you that a wide field of examination is still lying fallow and I beg to thank you for your kind attention.

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## ON THE TAXONOMY OF TETRANYCHID AND ALLIED GENERA. A NEW FAMILY AND TWO NEW SUB-FAMILIES IN ACARINA

By T. Sayed

- I. Oudemans 1927 describes (in the Ent. Berich. V. 7; No. 153 p. 177) the anterior, dorsal striped invagination he found in the genus *Pseudoleptus* Bruyant, 1911 (3 oct. Zool. Anz. V. 38; fa. 14—15; p. 340). He states that there are two stigmata in the bottom of this invagination.

In the same year (in Tijds. Ent., V. 70; p. LXXIII—Oct.) Oudemans points out that *Raoiella* Hirst, 1924 has the same characters found in *Pseudoleptus*. Ann. Mag. Nat. Hist. Ser. 9; XIV; pp. 522—523; pl. XVI.

In 1928 (Ent. Ber., V. 7; No. 159; pp. 287—288) Oudemans proposed the creation of a new family for both *Pseudoleptus* and *Raoiella* and called it *Pseudoleptidae*. He mentions that the new family agrees with *Tetranychidae* in the following characters:

- (1) The above mentioned striped invagination.
- (2) The styler-shaped mandibles.
- (3) The short cylindrical sense organ in the dorsal side of the maxillicoxa.

Oudemans states that *Pseudoleptidae* differs from *Tetranychidae* in the following:

- (1) In *Pseudoleptidae* there is no trace of peritreme.
- (2) Palpi are cylindrical.
- (3) Claws and empodium different and are described by Oudemans in Ent. Ber. 1. c.

- II. Oudemans 1938 "Nieuwe vondsten op het gebied der systematiek en der Nomenclatur der Acari p. 7;" refers to *Trichadenus* Rondani 1870 (Boll. Soc. Entom., II, part 2, p. 168). *Trichadenus* is only represented by *T. sericariae* found first on cocoons of *Sericari mori* L. 1780 and later on the underside of mulberry leaves. In Oudemans opinion the genus *Trichadenus* is identical with *Pseudoleptus*, mainly, because the general shape of *T. sericariae* is similar to that of *Stigmaeus floridanus* Banks which is a synonym of *Pseudoleptus floridanus*. Oudemans has rightly believed that old illustrations like Rondani's do not usually represent all facts and hence he was under the impression that the striped invagination is in all probability found in *Trichadenus sericariae*.

- III. Oudemans 1938 "Nieuwe Vondsten II in Tijdsch. Ent. V. 81; p. LXXV" proposes the name *Trichadenidae* to replace *Pseudoleptidae*. *Trichadenidae* comprises *Trichadenus* Rondani 1870 (= *Pseudoleptus* Bruyant 1911) and *Raoiella* Hirst 1924. The change of the name is due to the fact that *Trichadenus* is older than both *Pseudoleptus* and *Raoiella*.

- IV. The characters of these genera as shown by their authors or creators are as follows:—

*Trichadenus* Rondani: "Body sub-elliptic, slightly produced in the middle, moderately transversely constricted; palp 4—5 joints; dorsum and sides of the body without setae; palpi and legs covered with small glanduli or with

short glandular hairs; legs provided with a simple and short claw."

*Pseulectus* Bruyant: Body elongate, somewhat transversely constricted; dorsal and lateral setae 14—15 pairs; palp cylindrical, 4 jointed as drawn by Bruyant and 5 jointed as drawn by Oudemans. All tarsi with a finger-like projection or appendix and without typical claws; empodium divided and bears fine hairs; mandibles stylet shaped; anterior dorsal striped invagination found.

*Raoiella* Hirst: Body oval round; transverse line not constricting; on dorsum 16 pairs stiff, plumose, long, club-shaped hairs; chelicera styliform, palp 2-jointed, proximal joint not fused with capitulum; tarsi with 2 claws, well developed; empodium not divided and bears fine hairs. The anterior striped invagination is found as in *Pseudoeleptus*.

- V. In the same year (1938) Sayed created *Pseudotetranychinae* a sub-family comprising the genera *Raoiella* Hirst 1924 and *Phyllotetranychus* Sayed 1938. "Sur une Nouvelle Sous-Famille et Deux Nouveaux Genres de Tetranyques (Acariens). Bulletin du Muséum 2<sup>e</sup> Série—Tome X—No 6., pp. 601—610—1938. Paris." Sayed mentions that this sub-family differs from *Tetranychidae* in the following:—

- (1) Palpis only 2-jointed, whereas in *Tetranychidae* it is usually 4—5 joints. The palp is fused with the hypostome in *Phyllotetranychus* and not fused in *Raoiella*.
- (2) The striped invagination or the striated pouch, as called by Oudemans sometimes, and the complex respiratory system in contrast to the simple peritreme of other tetranychid genera.
- (3) Penis in both genera is long and fine.

The author states that the character of the palp is the most important feature of *Pseudotetranychinae*, since the striped invagination and the complex respiratory system are found in the genera *Tenuipalpus* Donn. and *Dolichotetranychus* Sayed.

*Phyllotetranychus* Sayed has the following features:

Body oval round, longer than broad; dorsal and marginal hairs are leaf-like and 16 pairs in number; 4 lobes produced anteriorly in the ♀; the striped invagination present; palp 2-jointed and fused with capitulum; tarsi with 2 claws and a single empodium bearing fine hairs.

- VI. On 6. 3. 1939 Oudemans wrote to the author stating that *Trichadenidae* is a synonym of *Pseudotetranychinae* and that he included *Phyllotetranychus* in *Trichadenidae*. He also stated that *Pseudoeleptus* and *Trichadenus* are synonyms as already mentioned and that *Dolichotetranychus* Sayed = *Pseudoeleptus* Bruyant.
- VII. The writer answered Oudemans pointing out the differences between *Pseudoeleptus* Bruyant, *Trichadenus* Rondani and *Dolichotetranychus* Sayed and stressed the fact that *Trichadenus* is a mite of no definite identity and that *Dolichotetranychus* differs from *Pseudoeleptus* in the following:
- (1) *Dolichotetranychus* has 3-jointed palp, ending with two digitiform projections (Sense hairs of some authors.)
  - (2) Dorsal and lateral hairs 10 pairs.
  - (3) The finger-like projection or appendix is found only in tarsi I and II.

If these characters are compared to those of *Pseudoleptus* already mentioned, *Dolichotetranychus* should stand as a valid genus and not a synonym of *Pseudoleptus*.

*Stigmaeus floridanus* Banks = *Dolichotetranychus floridanus* Banks = *Trichadenus australianus* Womersely 1943.

- VIII. Oudemans in his letter dated 29.5.39 to the writer expresses his doubt that *Trichadenus* is different from *Pseudoleptus*, but later in 18.7.39 he admits in his last letter that they are not synonyms but stand for two separate genera. He stated he was inclined to include *Trichadenus* in his family; and since the family bears the name of the oldest genus, "*Trichadenidae*" is the appropriate name and comprises the following genera:

*Trichadenus* Rondani 1870

*Pseudoleptus* Bruyant 1911

*Raoiella* Hirst 1924

*Phyllostetranychus* Sayed 1938

- IX. The fact that the late Oudemans has changed his opinion as to the synonymy of *Trichadenus* and *Pseudoleptus* seems to remain unknown to my other colleagues all over the world, and more especially, those interested in *Tetranychidae* and allied genera. This appears in the recent publications of Womersely and Baker. (Womersely, H, 1943. Australian Acarina of the Family *Trichadenidae*. Records S. Austr. Mus., V. VII, No. 3. Adelaide. Baker, E. W. (1945). Mites of the genus *Tenuipalpus* (Acarina: *Trichadenidae*) Proc. Ent. Soc., V. 47, No. 2. pp. 33—38. Washington).

There is no doubt that Rondani's description of *Trichadenus* is vague and inadequate and neither his description, nor his illustration coincide with *Pseudoleptus* Bruyant. Note Sayed, (1942). Contribution to the knowledge of the Acarina of Egypt. I The Genus *Raoiella* Hirst (*Pseudotetranychinae*—*Tetranychidae*). Bull. Soc. Fouad Ist Ent. XXVI. Cairo.

Oudemans 1938 admits that "nobody has looked for acari in mulberry after Rondani." It seems that such statement holds good in 1948. The identity or the exact position of *Trichadenus* remains uncertain and one can hardly find any correlation between this mite and the other genera, namely, *Pseudoleptus*, *Raoiella* and *Phyllostetranychus*.

Only collecting and description of acari on mulberry from Italy can throw light on the identity of *Trichadenus*. If *Trichadenus* is excluded from *Trichadenidae*, as it should be, the family should bear again the old name *Pseudoleptidae*, since *Pseudoleptus* is older than both *Raoiella* and *Phyllostetranychus*.

- X. Sayed, 1942 discusses *Trichadenus* position and suggests that *Tenuipalpus* Donnadieu might be included in *Pseudoleptidae* because in *Tenuipalpus* we find the following features distinguishing *Pseudoleptidae*:

- (1) The striped invagination or the striated pouch as termed by Oudemans.
- (2) There is no trace of the usual collar trachea or peritreme.
- (3) Palpi are cylindrical, elongate; palptarsus in continuation with palptibia.
- (4) Claws and empodium of *Tenuipalpus* are similar in general to those of *Raoiella*.

The writer states also that *Phytoptipalpus* Trägårdh 1905 offers to great extent similar characters.

- XI. Baker 1945 adds *Brevipalpus* Donn. 1875, *Tenuipalpus* Donn. 1875 and *Tegopalpus* Womersely 1940 to *Trichadenidae*. *Tegopalpus* is elongate-oval in form with mouth parts hidden under propodosoma. Palpi 2-jointed, legs short, tarsi I & II without appendix. The striated pouch, 2 claws and divided empodium are found.

Baker states that the genera of *Trichadenidae* differ from those of *Tetranychidae* in having highly simplified palpi. In fact, these genera, excluding *Trichadenus*, differ from *Tetranychidae* in other respects. The dorsal striped invagination and the breathing apparatus which is rather complex when compared to the simple peritreme of other tetranychids are among the characteristics of *Trichadenidae*. The double claw and the empodium which is either single or divided are not confined to *Trichadenidae*.

- XII. Since *Trichadenus* is out of place because its identity remains uncertain as already mentioned, the family should either bear the name of *Tenuipalpus* Donn. 1875 or *Brevipalpus* Donn. 1875. The writer proposes the name *Tenuipalpidae* since *Tenuipalpus* has priority of page when compared to *Brevipalpus*. [Donnadieu, A. L. (1875). Even if priority is disregarded, *Pseudoleptus* should not be chosen as type genus as it is not typical of the group. *Recherches pour servir à l'histoire des Tetranyques*, Ann. Soc. Linn. Lyon. pp. 111—117]. The genera of this family should include *Dolichotetranychus* Sayed 1938; its characters have already been mentioned. The writer has recently described *Aegyptobia* n. gen. The description is under publication and will appear shortly. There is no doubt that *Aegyptobia* lies in *Tenuipalpidae*. It bears the following features:

Body rather elongate, dorsal and marginal setae 16 pairs; of these, 8 pairs are spatulate and serrated. The rest are ordinary, plumose and rather short. Dorsal shield striated and without frontal projections. Palp 5-jointed; tarsi with a pair of 5-fold spines. The striated pouch or the striped invagination, together with the complex breathing apparatus are found.

The genus is so far represented by the species *Aegyptobia trågårdhi* n. sp. The name is a tribute to Professor Dr. Ivar Trågårdh, the leading acarologist of Sweden.

The only other genus that shares the general features of *Tenuipalpidae* is *Phytoptipalpus* Trågårdh 1905 which lies now in *Phytoptipalpidae* Ewing, a monotypic family. *Phytoptipalpus* differs only from the general characters of *Tenuipalpidae* in having three pairs of legs instead of four. The fact that all important characters of *Phytoptipalpus* agree with those of *Tenuipalpidae*, may suggest that the suppression of one pair of legs is not so important from a phylogenetical point of view, as it may mean the suppression of the adult stage. Hence, the genus may as well be joined with family *Tenuipalpidae*, and being considered as a separate sub-family. So far, there are only two species in the genus; *Phytoptipalpus paradoxus* Trågårdh which causes galls in the bark of Sunt (*Acacia nolitica* Wild) in Egypt and *Phytoptipalpus transitans* Ewing 1922. Proc. Ent. Soc. XXIV, p. 108. Washington. It makes galls on the bark of the jujube tree (*Zizyphus jujuba*) in India.

#### *General Characters of Tenuipalpidae* Nov. Family

- (1) The presence of the dorsal striped invagination or the striated pouch in the anterior part of the propodosoma. The invagination is funnel-shaped.



- (2) Palpi cylindrical, 2—5 joints, without tibial claw.
- (3) Penis long and fine when compared to the usual tetranychid type.
- (4) a V-shaped tracheal tube on both sides of the striated pouch ends with a pair of stigmata. This leads to another tube branching and extending laterally and seems to correspond with the collar trachea of tetranychids. This holds good in all genera except in *Pseudoleptus* and *Dolichotetranychus* in which the V-shaped tube is missing. *Tegopalpus* Womersely has not been yet examined by the author. Womersely has not referred to this point.
- (5) The double claw is found in all genera, but not typical in *Pseudoleptus* and *Dolichotetranychus*. The empodium is divided in *Pseudoleptus*, *Dolichotetranychus*, *Tegopalpus* and in some *Brevipalpus* species.

#### Family *Tenuipalpidae*

##### I. Sub-family *Tenuipalpinae*

Genera, *Brevipalpus* (Donn. 1875), *Tenuipalpus* (Donn. 1875), *Pseudoleptus* (Bruyant 1911), *Raoiella* (Hirst 1924), *Phyllotetranychus* (Sayed 1938), *Dolichotetranychus* (Sayed 1938), *Tegopalpus* (Womersely 1940), *Aegyptobia* n. gen. (Sayed).

##### II. Sub-family *Phytoptipalpinae*

Genus, *Phytoptipalpus* (Trägårdh 1905).

#### Key of *Tenuipalpinae*

- 1 ( 5 ) Palpi 2-jointed
- 2 ( 3,4 ) Dorsal and marginal hairs 16 pairs, leaf-like; 4 lobes produced anteriorly in ; palpi 2-jointed, fused with capitulum, 2 pairs of tracheal tubes anteriorly; 2 tarsal claws with a single empodium. *Phyllotetranychus* Sayed 1938
- 3 ( 2,4 ) Dorsal and marginal hairs 16 pairs, stiff, long, clubshaped, plumose; palp 2-jointed, not fused with capitulum; body oval round. *Raoiella*, Hirst 1924
- 4 ( 3,2 ) Dorsal and marginal hairs 12 pairs, of these 10 small and spatulate and 2 small and plumose; palp 2-jointed, not fused; mouth parts hidden under propodosoma; body elongate oval; empodium divided. *Tegopalpus* Womersely 1940
- 5 ( 1 ) Palpi 3—5 jointed
- 6 ( 7 ) Palpi 3-jointed, ending with 2 sense hairs; dorsal and marginal hairs 10 pairs, ordinary; a finger-like appendix on tarsi I, II., transverse line between proterosoma and hysterosoma; V-shaped tracheal tube missing; body elongate. *Dolichotetranychus* Sayed 1938
- 7 ( 6 ) Palpi 4—5 jointed
- 8 ( 9 ) All tarsi with a pair of 5-fold spines; dorsal and marginal hairs 16 pairs, of these, 8 spatulate and serrated, the rest ordinary, plumose and rather short; palp 5-jointed; body rather elongate; dorsal shield striated. *Aegyptobia* n. gen. Sayed
- 9 ( 8 ) No 5-fold spines on tarsi;
- 10 ( 13 ) Legs very much constricted; femur I, II suddenly thicker than trochanter
- 11 ( 12 ) Opisthosoma (posterior part of abdomen) parallel-sided; propodosoma much broader; dorsal shield somewhat striated. *Tenuipalpus* Donnadieu 1875

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- 12 (11 ) Abdomen oval, with ventral plates; dorsal shield reticulate. *Brevipalpus* Donnadieu 1875
- 13 (10 ) Legs without constriction; body elongate; dorsal and marginal setae 14—15 pairs; palp 5-jointed, all tarsi with appendix, a pair of tenent hairs, divided empodium V-shaped tracheal tube missing. *Pseudoleptus* Bruyant 1911.
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## DESCRIPTION OF A NEW GENUS AND TWO NEW SPECIES OF THE FAMILY TENUIPALPIDAE Sayed (Acarina)

By T. Sayed

### *Aegyptobia* n. gen.

Shape, oval elongate, twice as broad as long; propodosoma nearly as broad as hysterosoma. Dorsal shield striated and without frontal projections. Dorsal and marginal setae 16 pairs, 8 spatulate and serrate, the rest pointed and plumose. Ventrally, all tarsi with a pair of 5-fold spines. Palp 5-jointed, cylindrical, with 3 club-shaped; sense hairs, 9 pairs excluding those on coxae.

*Female*: Length, 223  $\mu$ i. Breadth, 114  $\mu$ i. Colour, orange red when alive with dark pigmented areas. Shape, oval elongate, twice as broad as long; propodosoma nearly as broad as hysterosoma. Dorsal shield structure is not reticulate, but of parallel striations. Eyes, two corneas, separate, anterior one smaller and oval, posterior one nearly round. Transverse line between propodosoma and hysterosoma does not reach lateral margins. On dorsum, 16 pairs of setae, 8 of these spatulate serrated in the posterior part of hysterosoma. Five pairs of this group are marginal. The other 8 pairs are pointed, plumose and lie in propodosoma and anterior part of hysterosoma. The latter group of hairs make four transverse rows, 2, 4, 6, 4. Dorsal shield without any frontal projection. Dorsal, anterior, striped invagination distinct and bound laterally by V-shaped tracheae, ending with a pair of stigmata. Another pair of tracheae corresponding to the collar tracheae with swollen, elongated ends lie posteriorly.

Ventrally, 9 pairs of ordinary hairs are found, 3 of these long and 4 short in the anal and vaginal areas. Moreover, a pair of hairs arise from each coxa. Ventral shield structure with parallel striations different from those of dorsal shield (fig. 3). Palp 5-jointed cylindrical, distal joint ends with 3 club-shaped setae or "sense hairs." Two rather long hairs arise from the penultimate segment. The longest hair arises from the second joint (fig. 7). Mandibles, styliform. All tarsi characterised by the presence of a pair of 5-fold spines ventrally (figs. 8, 9). Tarsus I, II with a finger-like projection and a pair of "sense hairs." Claws double, well developed, empodium single from which several fine hairs arise. Eight tenent hairs are found in all tarsi.

*Male*: unknown.

*Host Plant*: *Thuya orientalis* L.

*Locality*: Egypt (Dokki, Giza).

The name of this acarus is a tribute to the great acarologist of Sweden and the world, Professor Dr. Ivar Trägårdh who made the best contribution in the acarology of Egypt and the Sudan in his "Acariden aus Aegypten und dem Sudan." Moreover, the author is very grateful to Professor Trägårdh for he has been his first teacher in Acarina.

### *Brevipalpus olearius* n. sp.

*Female*: Length, 346  $\mu$ i; breadth, 163  $\mu$ i. Colour, red with dark pigmented spots when alive. Shape, oval, opisthosoma much narrowed when compared to propodosoma. Dorsal shield reticulate, anterior margin of propodosoma much produced making four lobes on either side (Fig. 5.). A transverse line lies between propodosoma and hystero-

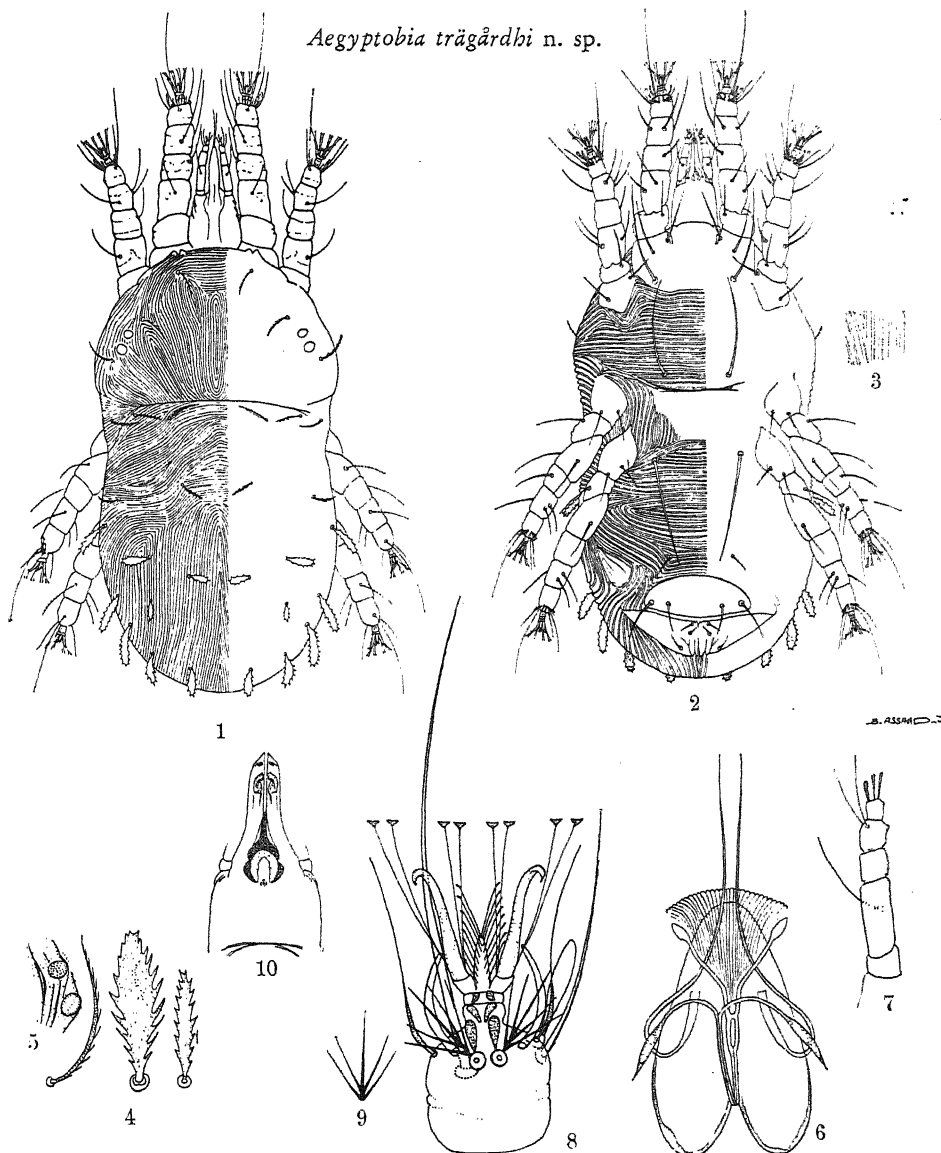
*Aegyptobia trågårdhi* n. sp.Fig. 1. Female, dorsal aspect  $\times 350$ Fig. 2. Female, ventral aspect  $\times 350$ .

Fig. 3. Striation of ventral shield.

Fig. 4. Dorsal setae.

Fig. 5. Eyes.

Fig. 6. Striped invagination, tracheal tubes, mandibles and mandibular plate.

Fig. 7. Palp, ventral.

Fig. 8. Tarsus I, ventral.

Fig. 9.  $\delta$  — fold spine.

Fig. 10. Rostrum.

*Brevipalpus olearius* n. sp.

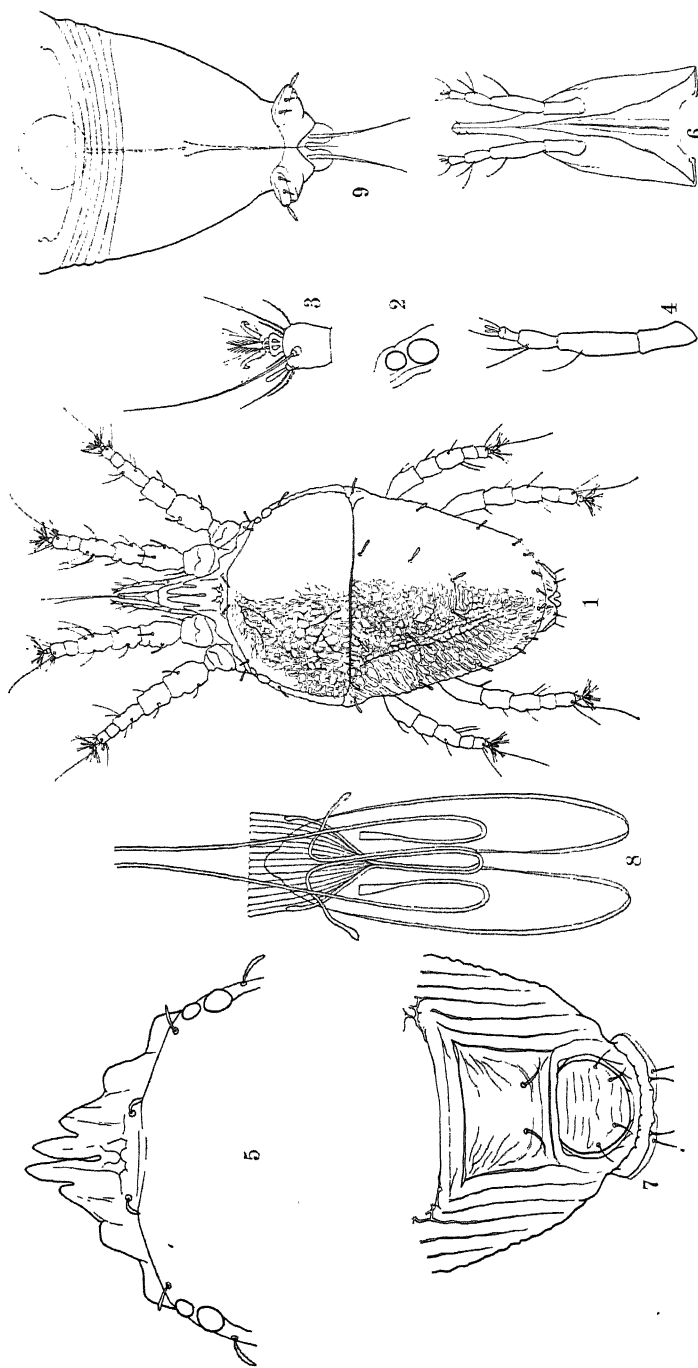


Fig. 1. Female, dorsal  $\times 193$ .

Fig. 2. Eyes.

Fig. 3. Tarsus I.

Fig. 4. Palp.

Fig. 5. Anterior projection of Dorsal Shield.

Fig. 6. Palpi and Rostrum.

Fig. 7. Posterior part of abdomen in ♀ (female).

Fig. 8. Striated pouch, mandibular plate and chelicera.

Fig. 9. Posterior part of abdomen in ♂ (male), ventral  $\times 350$ .

soma. On dorsum, 13 pairs of setae, short, plumose and not pointed; 3 of these in propodosoma and 10 in hysterosoma. Eyes, two corneas, separate, anterior one smaller. Dorsal striated pouch or striped invagination found anteriorly. A pair of V-shaped trachea ending with a pair of stigmata lie on both sides of the pouch. These extend posteriorly and lead to another pair of trachea with somewhat swollen ends. Mandibular plate, much elongated and narrowed; chelicera styliform. Rostrum much produced; palp 4-jointed, distal joint ends with 2 bristles and 2 digitiform projections "sense hairs." Tarsi with 2 well developed claws, a single empodium and 8 tenent hairs (Fig. 3). Tarsi I, II bear a finger-like projection.

*Male:* Length, 297  $\mu$ i; breadth, 123  $\mu$ i. Colour, red when alive. Posterior, ventral part of hysterosoma is similar to that of *Brevipalpus obovatus* (Fig. 9). The vesicula seminalis, ejaculatory duct, penis and sheath are distinct. Two supports are found in the extreme end of the body, also two lobes, each bearing three small setae. Ventrally, there are eight transverse parallel lines on the anterior part of the opisthosoma. These lines probably help in the twisting of the posterior abdominal part upward during fertilization.

*Host plant:* *Olea europaea* L.

*Locality:* Egypt (Dokki, Giza).

The writer is grateful to Dr. E. W. Baker of the National Museum, Washington, for he kindly sent him preparations of allied genera for comparison.

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## MITES PROBLEMS IN EGYPT

By T. Sayed

The writer wishes to express his grateful thanks to the International Entomological Congress for the kind invitation he received to discuss with his colleagues the acarina problems in Egypt. We all realise the great part played by Sweden for the cause of science in general and for the cause of natural history in particular. You will know later why an Egyptian acarologist, and more especially, the writer is grateful to Sweden.

One is bound to face acarina problems in Egypt owing to its geographical position, its favourable climatic conditions and the fact that the country is rich both in its plant and animal faunas.

It is probably advisable to mention a short historical survey of the attempts made to study the acarina of Egypt.

- I. The earliest record is that of the great Swedish Naturalist Linnæus who described some acari e.g. *Acarus aegyptius* Linné 1758 (Syst. Nat. X, p. 615) Synonym of *Hayalomma aegyptium* L; The genus *Hayalomma* was created by Koch in 1844.
- II. The second attempt was made by Savigny of the French Expedition who illustrated 10 acari in la Description de l'Égypte (pl. 9; figs. 4—13). These were identified by Audouin in 1827 (Descr. Égypte, t. XXII, pp. 425—430) and include a gamasid species belonging to the genus *Macrocheles* Latreille and 9 ixodid species, the determination of which is verified by G. Neumann (Revision de la famille de *Ixodidés*, Mém. Soc. Zool. France: 1er Mémoire, 1896 (t. XIV); 2, 1897 (t. X); 3<sup>e</sup>, 1899 (t. XII); 4<sup>e</sup>, 1904 (t. XIV)). André 1935 makes a critical study of these acari "Les Acariens figurés par Savigny dans la Description d l'Égypte. Ext. Bull. Mus. 2<sup>e</sup> Série — Tome VII — No. 3." The gamasid species is *Macrocheles marginatus* Herm. and the ixodids are *Ornithodoros Savignyi* Aud., *Argas testudo* Rossi, *Argas Hermannii* Aud., *Argas persicus* Oken, *Haemaphysalis Leachi* Aud., *Hayalomma aegyptium* L (duplicates in figs. 10, 11), *Rhipicephalus Linnaei* Aud. and *Hyalomma Forskaeli* Aud.
- III. The Swedish Zoological Expedition visited Egypt and the Sudan in 1901. The Expedition was under the direction of L. A. Jägerskiöld. Prof. Dr. Ivar Trägårdh was then a young member of the Expedition. Although he stayed only few months in Egypt and the Sudan his "Acarieden aus Ägypten und dem Sudan" is a great contribution to the knowledge of the acarina of Egypt. The book is 138 pages, 6 plates, 185 figures and appeared in 1904.
- IV. Willcocks 1913 refers to few species on plants and stored-products "Notes on some injurious and beneficial mites found in Egypt." Bull. Soc. Ent. d'Égypt, VI, no 1. January-March, Cairo. Willcocks was economic entomologist and devoted all his time for the study of insects. He did not study acarina and the majority of names mentioned in his book need revision.
- V. Debski 1918 "Mém. Soc. Ent. Égypte, V. I. fas. 4, p. 19" and 1919 "Bull. Soc. Ent. Égypte, pp. 30, 68" records some eriophyid species. He created new species without describing them. He relied on the symptoms of these mites and not on the characteristics or merits of the individuals. It is true the eriophyid mite is usually

specific to one host but this should not justify the creation of species on this assumption.

- VI. In recent years, the economic importance of acarina has been felt by both farmers and the Ministry of Agriculture. Several acarological infestations are received from different parts of the country. Some of these infestations were attributed to pathological diseases. In fact, such misapprehension took place in all countries where acarology did not exist or was at its birth.

The heavy infestation of a red spider mite in fig plantations all over the country and more especially in Fayoum and Kalubieh provinces lead to the serious consideration of the mites problems and to the establishing of a special branch for the study of Acarina in the Ministry of Agriculture.

In 1938, the writer was delegated by the Egyptian Government to study Acarina in Sweden under Prof. Dr. Trägårdh.

In Egypt mites infest the majority of fruits and vegetables causing in many cases heavy losses. Some of the main crops, ornamental plants, bulbs, tubers, and lawn grass are infested. Stored-products, especially in the North of the Delta, where the relative humidity is comparatively high are also infested with mites.

Mites infestations in other countries like U.S.A., Canada, Italy, Australia, and S. Africa affect our trade and our economy. Although we need some of the products of these countries like apples and pears, the majority of imported consignments are rejected because they bear mites which do not seem to be in Egypt. If such mites are introduced, they might be dangerous pests to our main crops. Blood-sucking mites often infest poultry and domesticated animals.

#### *Some Economic Pests*

1. *Eotetranychus cucurbitacearum* Sayed is the common red spider mite and infests figs (*Ficus carica* L), cucurbits, like water-melon, sweet lemon, cucumber and marrow. It also infests leguminous plants like french beans (*Phaseolus vulgaris*), cow pea (*Dolichos sesquipedalis*) and other vegetables like the egg-plant (*Solanum melongena* L), Colocasia (*Atrocarpus colocasia* L), okra (*Hibiscus esculentus* L) and soya beans (*Glycine soja*). Main crops infested with the mite are the ground nut (*Arachis hypogaea* L), sesame (*sesamum indicum*) and cotton. Like other acari, the common red spider has no hibernation period in Egypt. The life-cycle in summer is about 10 days.
2. *Brevipalpus obovatus* Donnadieu is mainly a citrus pest and more especially in the North of the Delta. The infestation is rather localised and causes a light brown colour in the rind followed by splitting of the epidermis. Guava, plums and apricots are occasionally infested.
3. *Anychus orientalis* Zachur, a citrus pest but more spread than the previous one. The colour of the rind is brown and remains smooth. Leaves of peaches, castor oil plant and ornamental trees are often infested with this mite.
4. *Brevipalpus pyri* Sayed infests apples, pears, plums, apricots, loquat, (*Eriobotrya japonica*) and some ornamental plants. The damage done to loquat and sometimes pears is marked.
5. *Dolichotetranychus floridanus* Banks infests the bermuda-grass (*Cynodon dactylon*) and pine apple (*Ananas sativus*) and is found also on the common reed (*Phragmites communis*). The mite is always hidden under leaf bases and hence, it can not be



controlled by spraying or dusting with chemicals and more especially in the case of the grass. Only agricultural methods have succeeded in controlling the mite.

6. *Phyllocoptruta oleivorus* Ashmed, the citrus rust mite causes rusetting in all citrus varieties except lemon where the symptoms become silvery. The pest has in all probability been introduced from Palestine three years ago, although the writer had only spotted the mite in December 1947 in a garden near Alexandria, he received fruits bearing the same symptoms from Rafah and Areesh in 1945 and 1946. Its life-history and control are being studied.
7. *Eriophyes vitis* or grape vine erinose is well established all over the country. The mite lives and produces inside the buds in winter. Heavily infested buds do not usually open. Opening of the buds is gradual and hence, repetition of treatments is necessary for its control. Emigration to new buds begins early in May in Giza and continues throughout the summer. Infested cuttings when placed in 54° C for 30 minutes become free from infestation without affecting growth.
8. *Aceria mangiferae* Sayed.  
The mite attacks the terminal buds of young and old mango trees in both heavy and light soils. Infested buds dry off and stop growing. Consequently, several lateral buds grow, but these are also infested and the stem looks stunted and deformed. The mite is prevalent all over the country and among the majority of mango varieties. Physiological disturbances and scale insect of the genus *Lepidosaphes* might cause similar symptoms when crowded round the terminal bud.
9. *Eriophyes cladophirus*, Nal. or tomato erinose is spread all over the country and is economically important. In this mite the leaflets of tomato become aborted and the whole plant looks wrinkled. The mite prevents flowering and causes flowers to fall. It is external and hence its control is not difficult.  
There are other pests of minor importance as *Eriophyes pyri*, *Paratetranychus terminalis* Sayed on vine leaves and mangoes and *Tenuipalpus granati* Sayed on pomegranate and vine leaves.

#### Methods of Control

1. Sulphur dust reduces the mites attack, but it is not a good ovicide hence, two treatments with 7 days in between in summer are needed. Dust is preferably used with tender foliage as in the case of ornamental flowering plants, vine leaves, seedlings and the majority of vegetables when infested with the common red spider mite. In tomato erinose sulphur mixed with slaked lime or clay in the ratio of 3:1 is used also 1% lime sulphur or Volk emulsion is quite effective.  
For *Eriophyes vitis*, only, dusting proved effective. This should be applied three times at least before flowers open, after setting of berries and 3—4 weeks later. The repetition is due to the fact that it takes time for the majority of buds to open. It should be noted that emigration begins early in summer and the mite should be controlled before it finds its way to the new buds. Heavy sulphur dust in a hot summer day causes scorching of vine leaves, berries and melons.
2. Lime-sulphur solution 1% is more effective than sulphur dusting. Flour paste in the rate of 1 lb. wheat flour to 4 liters water when heated gently and stirred up serves as a good spreader and sticker. The final spray solution is 1 litre lime-sulphur solution: 4 litres flour paste: 95 litres water. Other spreaders some of which are also stickers are used in the following proportions per 100 litre spray:

Casein 70—100 grams — Arabic gum 415 grams

Feneugreek flour 300 grams. Seeds are first roasted and then ground. — Agaral (I.C.I.) 200 c.c.

Citrus, vine trees, apples and pears should not be sprayed with lime-sulphur in summer. Miscible oil emulsions as Volk 1—1.25 % are used. Lime-sulphur has been used successfully in fig plantations, cucurbits and ground nut plant in summer. Sodium polysulphids in the same ratio gave better results than potassium polysulphides as used by Masse—63 grams potassium polysulphide: 100 litres water: 1/2 lb. soap.

3. Miscible oils in the rate of 1—1.25 % are very effective against all stages. For *Anychus orientalis*, *Brevipalpus obovatus* on citrus and *Brevipalpus pyri* on apples and pears. Miscible oil emulsions like Volk May should be used.
  4. D.D.T. and Gammexane compounds whether used as a dust or as a spray are not effective against tetranychids, allied genera and eriophyids.
  5. Organic chemicals in the market like D.N. III, Vapotone, Midol, Dynone and E. 605 have been tried. The trials made are not enough to judge these chemicals. Some of them like Dynone and E. 605 cause scerching in some plants.  
Direct chemical acaricides fail to control *Dolichotetranychus floridanus* when infesting *Cynodon dactylon*. The mite being lodged among tightly overlapping leaves is not within reach of chemicals. Only agricultural methods succeed in controlling the mite. Infested parts are shaved, collected and burnt. Stable manure and ammonium sulphate are added to the soil before watering.
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## REPRODUCTIVE ORGANS AND REPRODUCTION IN *TITYUS BAHIENSIS* (Scorpiones-Buthidae)

By *S. de Toledo Piza*

**MALE REPRODUCTIVE ORGANS** — The male reproductive organs of the scorpion *Tityus bahiensis* (Perty) are constituted by a testis and two large symmetrical groups of organs, each one represented by the seminal vesicles, the accessory glands, and the sheath of the copulatory organ.

The testis is formed by a thin U-shaped tube which ends anteriorly at the inner side of the compound organs just referred to. There is in the middle another tube connected with both branches of the U by means of transverse tubes. Blind tubes of varying sizes may be found anywhere in the testis.

In the outer part of each compound organ, considered as the sheath of the hemipenis, there is a chitinous blade, the hemipenis, proximally continued by a thin thread enclosed in its own sheath. The sheath of the hemipenis opens together with that of the other side into a single genital orifice.

**FEMALE REPRODUCTIVE ORGANS** — An U-shaped tube opens by its two branches into the genital orifice of the female. Another tube coming from the middle of the first one divides to form an Y, the branches of which reach those of the U at some distance from their ends. From the points of union on, till the ends of the U, there is no eggs production, a function which is performed by the whole rest of the organ. Due to the fact that the eggs produced at the out side of the organ give origin to embryos that develop inside, the name of ovariuterus was applied to it. The parts that do not produce eggs have been called vagins. Each vagin, a little before it reaches the genital opening, widens to form a seminal resceptaculum, the walls of which, strongly muscoulous, have an important part in the deliverance.

**COPULATORY ORGAN OF THE MALE** — Since the female has two vagins which go divergently from their common opening, it was formerly thought that the hemipenes were independent copulatory organs capable of penetrating both vagins at the same time. However, submitting living animals to the action of electric current or exciting directly the genital opening by means of a laboratory needle I was able to promote the egress of the copulatory organ, observing that, contrarily to what was expected, both blades came out together, forming a single tube full of seminal fluid. I could thus clearly seen that the scorpion, instead of having two independent copulatory organs as was supposed, has in reality a single one formed by the union of two distinct hemipenes.

**REPRODUCTION** — The ovarian follicles, each containing an egg, form a longitudinal row in the outer side of the ovariuterus. The egg-producing function is therefore in charge of a limited area of the organ, formed by a germinal epithel. Maturation of the eggs and fertilization are yet unknown. The developing eggs, without leaving their external situation, pass progressively inside in order to reach the interior of the ovariuterus, where they accomplish their development. The ovariuterus then appears as a series of wide chambers containing the embryos, separated from each other by narrow segments. The embryos, entirely free in their individual chambers,

are holden by funicles connecting them with the vitellogenic organ developed in the places occupied in the beginning by the unsegmented eggs, that is, outside the ovario-uterus. Only a limited number of eggs enter into development at each reproduction time. The rest remain at the external wall of the ovario-uterus, where they attend for their opportunity. The funicle connecting the vitellogenic organ with the embryo, which may be called umbilical funicle, is inserted in the middle of the fourth dorsal abdominal plate of the developing individual.

**BIRTH** — The young are born within the envelop of the egg, one by one or in small groups of two, three, or more, separated by intervals. The female during deliverance rises up on its feet, removing with the aide of the ones belonging to the first and the second pairs the newborns from the neighbourhood of its genital opening. The internal pression that determines the passage of the young through the comparatively narrower genital orifice is very strong and must be attributed to a powerful contraction of the walls of the seminal resceptacles. Either one or other extremity of the animal can force the genital opening of the female, what depends upon its position in the ovario-uterus. After being born the young scorpions stay motionless for a short time and soon begin to move very slowly in order to become free from the egg membrane. Then they climb to the female's back, sometimes with the egg membrane still adherent to their tail. The yolk-forming organ which lays outside the ovario-uterus being bounded by the same envelop enclosing the entire embryo, passes inside some time before the deliverance, leaving in the wall of the ovario-uterus the orifice throughout which it has passed. The connection of the organ with the body of the newborn is in the meanwhile interrupted at the surface on the latter, leaving there a minute round scar—the umbilicus dorsalis, which can be observed as soon as the animal looses its envelop and remains visible until the end of the first instar.

The largest brood presently observed in the laboratory was composed of 26 individuals. Still larger ones may be expected since it was once found a female with 35 embryos in the ovario-uterus.

The first ecdysis occurs 4 to 6 days after birth.

One of the most remarkable events in the life history of *Tityus bahiensis* is that the female of this scorpion, as verified in the laboratory, can give birth at least to another brood without being mated again. Since the resceptacula seminales must have been evacuated by the passage of large embryos, it may be thought that a considerable amount of eggs are fertilized by the spermatozoa from one single mating and that the developing eggs inside the ovarioturus exercise a sort of inhibitory effect against the eggs still in the follicles. The latter have to attend there for the evacuation of the ovario-uterus and the reorganization of its wall. The time separating one deliverance from the next was of 92 days.

**GONADIC HERMAPHRODITISM** — The presence in the testis of a limited number of eggs is of common occurrence.

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STUDIES ON THE COMPARATIVE MORPHOLOGY OF  
THE MESOSTIGMATA

By *I. Trägårdh*

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